United States Government Accountability Office

Report to the Committee on Armed Services, House of Representatives

February 2022

LITTORAL COMBAT SHIP

Actions Needed to Address Significant Operational Challenges and Implement Planned Sustainment Approach

Accessible Version

GAO-22-105387

GAO Highlights

Highlights of GAO-22-105387, a report to the Committee on Armed Services, House of Representatives

Why GAO Did This Study

The LCS is designed to operate in shallow waters close to shore—known as the littorals. The Navy estimates it will cost over $60 billion to operate and support the 35 LCS it plans to build, including the 17 it has already delivered.

A House report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2020 included a provision for GAO to review the LCS's affordability and sustainability. This report examines the extent to which the Navy has (1) demonstrated that the LCS has the operational and warfighting capabilities to perform its missions; (2) implemented the recommendations in the Navy's 2016 Review; and (3) updated its cost estimates to account for revised operational and sustainment concepts.

GAO reviewed relevant laws, regulations, Navy guidance; analyzed LCS cost data for fiscal years 2009 to 2019; and interviewed relevant officials. This is a public version of a sensitive report that GAO issued in August 2021. Information that the Navy deemed sensitive has been omitted.

What GAO Recommends

GAO recommends, and the Navy concurs with, developing a comprehensive plan to address deficiencies, performing adequate testing of the mission modules, and implement lessons learned; making deployments contingent on progress in addressing gaps in capabilities, and determining tasks Navy personnel and contractors will perform, among others.

GAO also recommends, and the Navy partially concurs with, updating and improving LCS cost data, as discussed in the report.

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What GAO Found

The Littoral Combat Ship (LCS) fleet has not demonstrated the operational capabilities it needs to perform its mission. Operational testing has found several significant challenges, including the ship's ability to defend itself if attacked and failure rates of mission-essential equipment. The Navy is also behind schedule in developing the various mission modules—different configurations of key systems for different missions, such as mine countermeasures—for the LCS. In addition, GAO found that the LCS has frequently encountered challenges during deployments. The Navy has begun to take steps to address some of these issues, but it does not have a comprehensive plan to address the various deficiencies identified during testing and deployments. Without a comprehensive plan to address deficiencies, perform adequate testing of the mission modules, and implement lessons learned from completed deployments, the LCS will remain at risk of being unable to operate in its intended environment. Further, gaps between desired and demonstrated capabilities have substantial implications for the Navy's ability to deploy the LCS as intended. Until the Navy makes future operational deployments contingent on progress in addressing gaps between desired and demonstrated capabilities, the LCS will continue to be dependent in combat and require protection by multi-mission combatants.

The Navy has implemented eight of the 10 recommendations from its 2016 Review of the LCS program. Among other things, it has implemented new approaches for assigning and training sailors for the LCS crew. However, the Navy is facing challenges in implementing a revised maintenance approach, under which Navy personnel will perform some maintenance currently being conducted by contractors. Until the Navy determines the specific tasks Navy personnel will perform, it risks not being able to meet the maintenance needs of the LCS, thus hindering the ships' ability to carry out their intended missions.

The Navy's operating and support (O&S) cost estimates for the LCS do not account for the cost implications of its revised maintenance approach. Specifically, the Navy has not assessed the cost implications of its revised maintenance approach, and thus lacks a clear picture of its impact on O&S costs. Some of the Navy's O&S actual cost data are also incomplete and inaccurate. For example, the Navy reported on each O&S cost element for the seaframes in its Visibility and Management of Operating and Support Costs database, but it reported only on the maintenance cost element for the mission modules. Further, the Navy does not report maintenance costs separately for each mission module, but instead totals those costs for all mission modules and divides by the number of seaframes in the fleet. Without complete and accurate cost data, the Navy is at risk of failing to anticipate O&S cost increases that could create challenges in funding LCS as intended or delivering capabilities when expected.

Finally, the Navy has not updated its O&S cost estimates to reflect its revised operational and sustainment concepts and has not incorporated actual cost data into some of its estimates. Without complete information on the cost of implementing the revised operational and sustainment concepts, and the use of actual cost data, the Navy will not be able to analyze the differences between estimates and actual costs—important elements for identifying and mitigating critical risks to the LCS.

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Abbreviations

ASW	anti-submarine warfare
DOD	Department of Defense
DOT&E	Director, Operational Test and Evaluation
LCS	Littoral Combat Ship
MCM	mine countermeasures
O&S	operating and support
PEO	Program Executive Office
PMS	Program Manager - Ships
RDT&E	Research, Development, Test, and Evaluation
SUW	surface warfare
VAMOSC	Visibility and Management of Operating and Support Costs

U.S. GOVERNMENT ACCOUNTABILITY OFFICE
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February 24, 2022

The Honorable Adam Smith
Chairman
The Honorable Mike Rogers
Ranking Member
Committee on Armed Services
House of Representatives

The United States Navy has worked to develop and refine the concept of operations for the Littoral Combat Ship (LCS) since the program began in 2004. The LCS is designed to operate in shallow waters close to shore—known as the littorals—to conduct missions that are challenging for the Navy's larger ships. The LCS consists of two distinct parts: the ship itself (seaframe) and the mission package it is expected to carry and deploy. The respective packages are for anti-submarine warfare, mine countermeasures, and surface warfare missions. The Navy conceived the LCS as an innovative platform for achieving its security objectives that could, among other things, provide the Navy's predominant mine countermeasures capability at an affordable cost while freeing up the more expensive multi-mission, large surface combatants like cruisers and destroyers to focus on their primary missions. However, we reported in 2017 that costs to construct the ships have more than doubled from initial expectations, and promised levels of capability have been unfulfilled.[1]

As of fiscal year 2019, the Navy had spent over $28 billion (in constant fiscal year 2019 dollars) to develop and build 32 LCS. As of December 2019, the Navy planned to build an additional three LCS, for a total of 35 LCS by 2025. While acquisition costs have been significant, operating and support costs make up approximately 70 percent of total program life-cycle costs of Navy ships. The Navy has already spent at least $3.3 billion to operate and support 17 LCS since 2008. In 2011 the Navy estimated that it would cost $38 billion (in constant fiscal year 2019 dollars) to operate and support 35 LCS for their planned service lives of

[1]GAO, *Littoral Combat Ship and Frigate: Delaying Planned Frigate Acquisition Would Enable Better-Informed Decisions,* GAO-17-323 (Washington, D.C.: Apr. 18, 2017).

25 years. However, as of December 2018 that estimate had increased to over $60 billion (constant fiscal year 2019 dollars).[2]

The LCS was expected to provide increased warfighting flexibility to the Navy fleet and close critical warfighting gaps, but over the years, the Navy has experienced challenges in demonstrating these capabilities. In 2016, the USS *Fort Worth's* initial deployment ended with major engine problems and the USS *Milwaukee* was unable to complete its voyage from the construction shipyard to its homeport, also because of engine problems. As a result, the Chief of Naval Operations directed a 60-day review of the LCS program (2016 Review). The 2016 Review was launched in an effort to address the program's challenges with executing the ships' unique operational and sustainment[3] concepts.[4] In response to recommendations from the 2016 Review, the Navy announced fundamental changes to these operational and sustainment concepts, including for the ships' crewing (providing the required complement of officers and enlisted personnel aboard a ship); manning (which we refer to in this report as "filling positions," or providing the personnel reflecting their grades and occupational groups); training; maintenance; and warfighting concepts.[5]

In June 2019 the House Armed Services Committee, in a report accompanying a bill for the National Defense Authorization Act for Fiscal Year 2020, included a provision for us to review the affordability and sustainability of the LCS, including implementing the revised operational concepts, conducting support and maintenance of the LCS while it is deployed overseas, and developing operating and support (O&S) costs

[2]GAO, *Navy Shipbuilding: Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions,* GAO-20-2 (Washington, D.C.: Mar. 24, 2020).

[3]DOD defines sustainment as the provision of logistics and personnel services required to maintain and prolong operations until a mission is successfully accomplished.

[4]The LCS's unique operational and sustainment concepts include having multiple crews assigned to each ship (referred to as rotational crewing), minimally filling positions, and maintenance and logistics strategies, which rely heavily on contractors to provide sustainment support.

[5]Department of the Navy, Chief of Naval Operations, *Littoral Combat Ship Review Team Report* (May 17, 2016).

for the LCS program.[6] This report examines the extent to which the Navy has (1) implemented the recommendations and addressed the challenges identified in the 2016 Review; (2) updated its LCS cost estimates and included actual cost data to account for the revised operational and sustainment concepts; and (3) demonstrated that the LCS has the operational and warfighting capabilities it needs to perform its missions.

This report is a public version of a sensitive report that we issued in August 2021.[7] We subsequently worked to obtain DOD's review and concurrence on changes necessary for public release. DOD deemed some of the information in our August 2021 report to be sensitive, which must be protected from public disclosure. Therefore, this report omits sensitive detailed information pertaining to performance capabilities, personnel requirements, and sustainment challenges of the LCS. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

To address our first objective, we reviewed the recommendations from the 2016 Review. Specifically, we reviewed and analyzed those recommendations and compared them to the steps the Navy had taken to implement them. Two GAO analysts independently evaluated the 2016 Review and the steps taken to implement its recommendations in order to determine the extent to which the recommendations were implemented. Each analyst assigned a status of either implemented, in progress, or not implemented to each recommendation. These analysts reviewed documentation on these recommendations and challenges in implementing them, such as program briefings, unit personnel documents, training documents, and maintenance planning documents. The analysts also assessed the documentary and testimonial evidence we collected against DOD and Navy guidance and against standards for

[6]H.R. Rep. No. 116-120, at 92 (2019). In response to this House report, we also issued GAO, *Littoral Combat Ship: Unplanned Work on Maintenance Contracts Creates Schedule Risk as Ships Begin Operations*, GAO-21-172 (Washington, D.C.: Apr. 29, 2021).

[7]GAO, *Littoral Combat Ship: Actions Needed to Address Significant Operational Challenges and Implement Planned Sustainment Approach,* GAO-21-331SU (Washington, D.C.: Aug. 5, 2021).

internal control in the federal government.[8] Once agreement was reached between the two analysts, a third independent analyst conducted an additional review to verify the accuracy of the analysis.

To address our second objective, we reviewed available O&S costs for the seaframes and mission modules from the Navy's O&S cost estimates created between 2004 and 2019 and reviewed actual O&S cost data from fiscal years 2009 to 2019 in the Naval Visibility and Management of Operating and Support Costs (VAMOSC) database. Additionally, we reviewed DOD and Navy guidance, such as DOD Instruction 5000.73, *Cost Analysis Guidance and Procedures*; Secretary of the Navy Instruction 7000.29A, *Naval Visibility and Management of Operating and Support Costs Program Data Collection*; and leading practices for cost estimating in GAO's *Cost Estimating and Assessment Guide*.[9] Additionally, we took steps to assess the reliability of the data sources used in this report. We reviewed documentation provided by the Navy in response to our questions regarding the cost data for the LCS. Navy officials provided information that included an overview of the data sources, how the information was collected, definitions of variables, data quality controls, and perceptions about overall data quality. We also performed electronic data testing for missing data, outliers, and obvious errors. We interviewed Navy officials to obtain clarification and discussed our plans for how we intended to use the data. We determined that the data are reliable for the purpose of reporting on O&S costs for the seaframes and the minimum maintenance costs for the mission modules, but that they are not reliable for reporting on overall O&S costs, as discussed later in this report.

[8]DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense (IG DOD) and Internal Audit Reports* (Dec. 18, 2014) (incorporating change 1, Jan. 31, 2019); Department of the Navy, Chief of Naval Operations Instruction (OPNAVINST) 3501.352A, *Required Operational Capabilities and Projected Operational Environment for the Littoral Combat Ship* (Apr. 8, 2014); Department of the Navy, COMNAVSURFPAC/COMNAVSURFLANT Instruction 3502.7A, *Surface Force Training and Readiness Manual* (Jan. 9, 2020); and GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[9]DOD Instruction 5000.73, *Cost Analysis Guidance and Procedures* (Mar. 13, 2020); Secretary of the Navy (SECNAVINST) Instruction 7000.29A, *Naval Visibility and Management of Operating and Support Costs Program Data Collection* (Jan. 26, 2021); and GAO, *Cost Estimating and Assessment Guide*, GAO-20-195G (Washington, D.C.: March 12, 2020).

To address our third objective, we reviewed reports from the Director, Operational Test and Evaluation (DOT&E), from 2003 through 2020 on LCS operational performance and related testing. We also reviewed post-deployment reports from 2016 through 2020; casualty reports from 2019 and 2020; lessons learned reports from 2013, 2017, and 2018; and other documents regarding the LCS's ability to perform its missions.[10] We assessed the documentary and testimonial evidence we collected against DOD and Navy guidance, such as DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense and Internal Audit Reports*; OPNAVINST Instruction 3501.352A, *Required Operational Capabilities* and *Projected Operational Environment for the Littoral Combat Ship*; and GAO's *Standards for Internal Control in the Federal Government*.[11] Additionally, we reviewed our prior work on LCS operations and sustainment.[12]

For all objectives, we analyzed documentation and interviewed knowledgeable officials from over 20 offices, including the Office of the Secretary of Defense and Navy offices on LCS operations and sustainment. We assessed the documentary and testimonial evidence we collected against DOD and Navy guidance, including DOD Manual 5010.12-M, *Procedures for the Acquisition and Management of Technical Data*; the Navy's *Surface Force Training and Readiness Manual*; GAO's *Standards for Internal Control in the Federal Government*; and guidance in GAO's *Cost Estimating and Assessment Guide*.[13] Additional details about our objectives, scope, and methodology can be found in appendix I.

We conducted this performance audit from November 2019 to August 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for

[10]A casualty report is an operational report used to document mechanical issues the crew encounters. These reports represent significant deficiencies to the pieces of equipment that contribute to the ship's ability to perform its missions.

[11]DOD Instruction 7650.03; OPNAVINST 3501.352A; and GAO-14-704G.

[12]For example, see GAO, *Littoral Combat Ship: Deployment of* USS *Freedom Revealed Risks in Implementing Operational Concepts and Uncertain Cost,* GAO-14-447 *(Washington, D.* C.: July 8, 2014). For a list of reports on LCS, see the Related GAO Products page at the end of the report.

[13]DOD Manual 5010.12-M; *Procedures for the Acquisition and Management of Technical Data* (May 1993) (incorporating change 1, Aug. 31, 2018); Navy, COMNAVSURFPAC/COMNAVSURFLANT Instruction 3502.7A; GAO-14-704G; and GAO-20-195G.

our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We subsequently worked from August 2021 to February 2022 to prepare this version for public release. This public version was also prepared in accordance with those standards.

Background

Overview of the Littoral Combat Ship Program

Each LCS consists of two distinct parts—the ship itself (seaframe) and the mission package it carries aboard to perform a specific mission.[14] The Navy developed two variants of the seaframe—the *Freedom* and the *Independence* (see fig. 1). Each seaframe carries guns and missiles and has four waterjets driven by diesel and gas turbine engines, which are designed to help the ship meet its sprint speed and cruising ranges. The LCS is designed to perform its mission with a mission package aboard for either an anti-submarine warfare, mine countermeasures, or surface warfare mission. The mission package consists of mission modules with support equipment, along with the support aircraft and the crew of the seaframe. A mission module consists of systems—such as sensors, weapons, and vehicles; and support equipment—such as containers, hardware, and software. The support aircraft, or aviation detachment, is a separate group of flight and support crew that is operated, maintained, and funded separately from the LCS seaframe and its mission modules.

[14]See appendix II for additional information on the LCS design, capabilities, mission modules, and acquisition strategy.

Figure 1: Littoral Combat Ship Seaframes

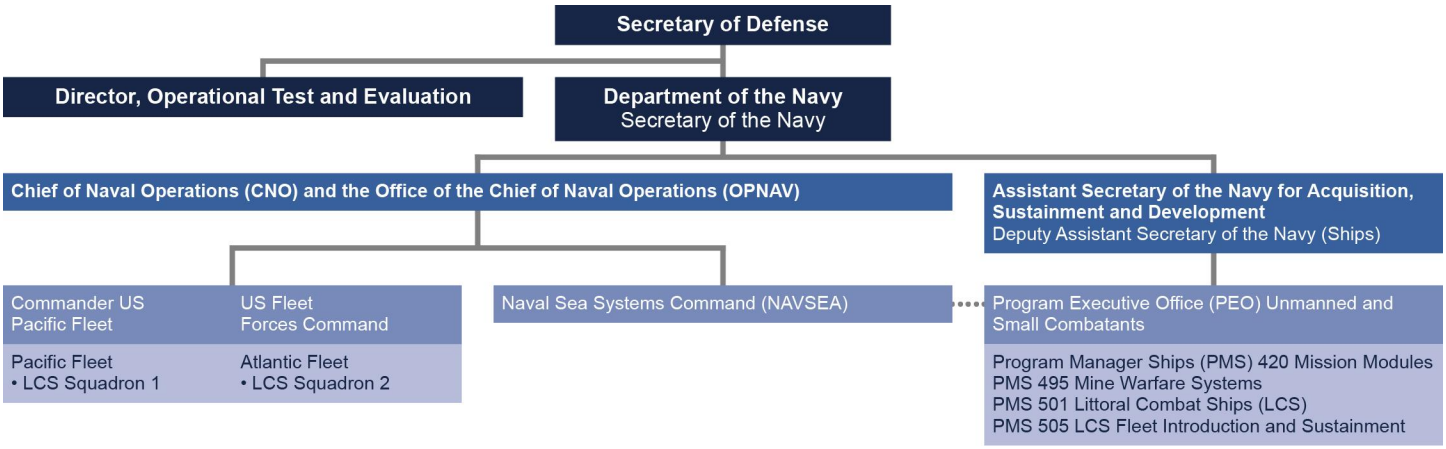
Sources (left to right): U.S. Navy/Petty Officer 2nd Class James Evans and U.S.Navy/Chief Petty Officer Shannon Renfroe. | GAO-22-105387

We use the term “LCS” in this report to refer collectively to both the seaframes and the mission modules. Due to our focus on seaframe and mission module sustainment, we will not be reporting on the aviation detachment; as such, we generally do not use the term “mission package.” In this report we will generally refer either to missions (that is, to one of the three mission activities—anti-submarine warfare, mine countermeasures, and surface warfare); or to one or more of the 12 modules (that is, to any of the groups of sensors, weapons, vehicles, or support equipment within a mission package). There are 12 modules within the three missions. Specifically, there are two modules within the anti-submarine mission, six modules within the mine countermeasures mission, and four modules within the surface warfare mission.

Roles and Responsibilities for Overseeing and Managing the LCS Program

Several DOD organizations and Navy commands have responsibilities for respectively managing the LCS program; overseeing testing and evaluation; training; maintenance; and operation of the seaframes and mission modules (see fig. 2).

Figure 2: Key Sustainment Stakeholders for the Littoral Combat Ship (LCS) Program



Source: GAO analysis of Department of Defense and Navy documentation. | GAO-22-105387

Note: The dotted line denotes Naval Sea Systems Command's support role for the PEO. Solid lines denote direct lines of authority.

- **Director, Operational Test and Evaluation** is responsible for reviewing and analyzing the results of operational testing and evaluation conducted for each major DOD acquisition program, providing independent assessments to the Secretary of Defense and Congress, and confirming operational effectiveness and suitability of the defense system in combat use, among other things.[15]
- **Naval Sea Systems Command** is responsible for engineering, building, purchasing, and maintaining ships, submarines, and combat systems.[16]
- **Program Executive Office Unmanned and Small Combatants** designs, develops, builds, maintains, and modernizes the Navy's unmanned maritime systems, mine warfare systems, and small surface combatants.[17] The following Program Manager - Ships (PMS)

[15]DOD Directive 5141.02, *Director of Operational Test and Evaluation (DOT&E)* (Feb. 2, 2009); and 10 U.S.C. § 2399.

[16]OPNAVINST 5450.340A, *Mission, Functions, and Tasks of Commander, Naval Sea Systems Command* (June 29, 2016) (incorporating change 1, Dec. 9, 2019).

[17]The Program Executive Office Littoral Combat Ship was renamed in 2018 to the Program Executive Office Unmanned and Small Combatants. The Program Executive Office Unmanned and Small Combatants is also responsible for acquiring and maintaining the future Frigate, the Multi Mission Surface Combatant, and the international small surface combatants. Memorandum from the Assistant Secretary of the Navy (Research, Development & Acquisition), *Establishment of Program Executive Office Unmanned and Small Combatants* (Mar. 13, 2018).

organizations within the Program Executive Office are directly aligned with the oversight and execution of the LCS program:

- PMS-505: LCS Fleet Introduction and Sustainment
- PMS-501: Littoral Combat Ships
- PMS-495: Mine Warfare
- PMS-420: LCS Mission Modules

- **LCS squadrons** consist of seaframes, mission modules, and their crews, as well as shore support personnel for numerous functional area requirements, including, among others, administrative, personnel, operational, maintenance, logistics, training, and facilities. The LCS has two squadrons: LCS Squadron – One, in San Diego, California; and LCS Squadron – Two, in Mayport, Florida.

2016 LCS Review Team Report

As a result of persistent problems regarding cost, schedule delays, and performance, among others faced by the LCS, in February 2016 the Chief of Naval Operations established an LCS review team to conduct a 60-day assessment of the LCS program's operational and sustainment concepts, including crewing and filling positions, training, maintenance, and the warfighting capability of the LCS. In May 2016 the review team issued its final report, making 10 recommendations and identifying 33 long-term actions to significantly change the program's operational and sustainment concepts in order to increase the time the ship spends in a deployed status (see fig. 3).[18]

[18]See appendix III for more details about long-term actions from the 2016 Review.

Figure 3: Summary of Revised Operational and Sustainment Concepts for Littoral Combat Ship (LCS) Program, as of December 2020

	LCS program before 2016 review	LCS program after 2016 review
Rotational crewing	Three crews rotating between two ships, with either ship being able to deploy	Two crews rotating on one ship and that one ship will be deployed
Filling positions[a]	Originally planned at 40 sailors in 2005, then increased to 50 in 2013 operating the seaframe; as well as 15-20 sailors operating the mission modules separately and operating under separate commands	Merge crew for seaframe and mission modules for a combined crew of about 70 sailors operating under one command
Training	Rely heavily on simulated training at the training facility	Assign dedicated LCS training ships to allow sailors to meet training competencies and relieve deploying ships from training requirements; crew would specialize in specific missions
Maintenance	Maintenance that would typically be performed by the crew is outsourced to contractors to conduct maintenance on the ship	Transition to Navy personnel who will be assigned to the LCS squadron to perform maintenance on the ship; some contractor maintenance will still be necessary
Warfighting capability	Swap modules for specific missions, as needed, during deployments and improve operational availability for the seaframe	Assign modules to groups of ships focused on a specific mission and improve operational availability for the seaframe

Source: GAO analysis of Navy documentation. | GAO-22-105387

[a]In this report, we are using the term "filling positions" to refer to "manning" (providing the needed inventory of individual personnel, reflecting their grades and occupational groups).

Operating and Support Cost Reporting for the LCS Program

There are various costs associated with operating and supporting the LCS program. The Navy prepares separate O&S cost estimates for the seaframe and the mission module programs because they are considered two distinct major defense acquisition programs.[19] For each one, the Navy

[19]A major defense acquisition program is defined in statute as a DOD acquisition program that is not a highly sensitive classified program as determined by the Secretary of Defense, or that is estimated by the Secretary of Defense to require eventual total expenditure for procurement, research, development, test, and evaluation of more than $480 million in fiscal year 2014 constant dollars or, for procurement, more than $2.79 billion in fiscal year 2014 constant dollars.

prepares program life-cycle cost estimates and O&S cost estimates within the Selected Acquisition Reports (see table 1).

Table 1: Cost Estimates for the Littoral Combat Ship

n/a	Program life-cycle cost estimates	Selected Acquisition Reports
Requirement	10 U.S.C. § 2334;[a] DOD Cost Assessment and Program Evaluation, DOD *Cost Estimating Guide* (December 2020); and DOD Instruction 5000.73, *Cost Analysis Guidance and Procedures* (March 13, 2020).	10 U.S.C. § 2432[b]
Purpose	Ensures that cost estimates and analyses provide accurate information and realistic estimates for acquisition programs.	Provides Congress with an annual comprehensive report and quarterly follow-up reports on cost, schedule, and performance for major defense acquisition programs in comparison with the acquisition baseline.
Use	Used as the program's baseline and associated budget to provide confidence that the program can be completed without the need for significant adjustment to future program budgets. It is also used at key decision points and milestone reviews to ensure sound sustainment strategies and address key drivers of costs.	Used as primary means to convey information to Congress on the status of defense acquisition programs.

Source: GAO analysis of statutes and DOD documentation. | GAO-22-105387

[a]Section 2334 of Title 10, United States Code, requires that independent cost estimates including life-cycle costs be conducted or approved by the Director of Cost Assessment and Program Evaluation on major defense acquisition programs prior to entering a milestone phase.

[b]The National Defense Authorization Act for Fiscal Year 2018 terminated several DOD reporting requirements, including the requirement for Selected Acquisition Reports, effective December 31, 2021. Pub. L. No. 115-91, § 1051 (2017). The National Defense Authorization Act for Fiscal Year 2020 directed the Secretary of Defense to submit a proposal for an alternative methodology for reporting on all acquisition programs. Pub. L. No. 116-92, § 830 (Dec. 20, 2019). DOD submitted a proposal in November 2020, but as of March 2021, DOD officials did not provide information on a replacement product.

DOD Instruction 5000.73, *Cost Analysis Guidance and Procedures*, and the Office of Cost Assessment and Program Evaluation's *Operating and Support Cost-Estimating Guide* (the Guide) provide direction to the service components on developing estimates to support various analyses and reviews throughout a program's life cycle.[20] The Office of Cost Assessment and Program Evaluation's Guide defines O&S costs as the costs of all sustainment incurred from the initial weapon system's deployment through the end of system operations. These include costs for personnel, equipment, supplies, software, and services associated with operating, modifying, maintaining, supplying, training, and supporting a system in the DOD inventory. O&S costs are categorized into six

[20]DOD Instruction 5000.73; and DOD, Office of Cost Assessment and Program Evaluation, *Operating and Support Cost-Estimating Guide* (March 2014) (updated September 2020).

common elements, including unit operations and maintenance.[21] According to DOD's *Cost Analysis Guidance and Procedures*, as a program matures, components must continue to track and assess O&S cost estimates yearly throughout a major defense acquisition program's lifecycle to determine whether early information and assumptions remain relevant and accurate.

Each military department maintains a database that collects historical data on O&S costs for major fielded weapon systems. The Office of Cost Assessment and Program Evaluation provides policy guidance on this requirement, specifies the common format in which the data are to be reported, and monitors its implementation by each of the military departments. The Navy uses its VAMOSC system to collect and report on historical O&S costs for weapon systems, including the LCS.

LCS Role in Navy Force Structure Plans and Current Status of the LCS Program

According to the Navy, the LCS was designed as a surface combatant to replace the missions of the Oliver Hazard Perry-class Frigates, Avenger-Class Mine Counter-Measures, and Cyclone-class coastal patrol ships. The Navy's goal is to have its small surface combatants, including the LCS, comprise nearly 15 percent of the fleet's 355 ships between fiscal years 2031 and 2033.[22] The Navy had planned to operate 35 LCS.[23] As of February 2021, the Navy planned to decommission the first four LCS and operate the remaining 31 with six designated as training ships and 25 as deployable ships. As of September 2019 contractors had built and delivered 17 of the 35 ships expected to be built eventually. The Navy has

[21]The Operating and Support Cost Estimating Guide categorizes O&S costs into the following six elements: unit-level manpower (which we term "unit-level personnel"), unit operations, maintenance, sustaining support, continuing system improvements, and indirect support.

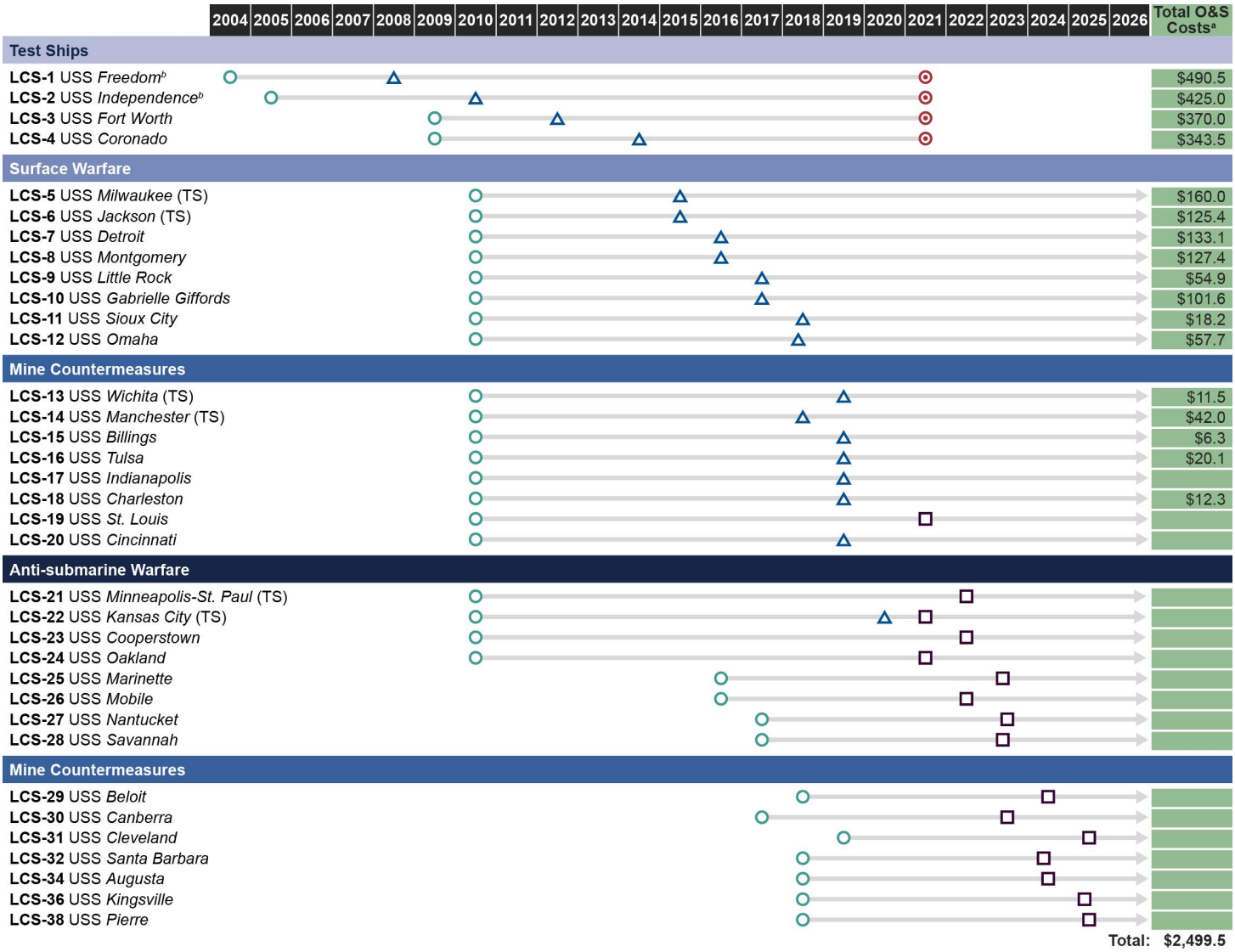
[22]DOD is revising its plan to increase the Navy's fleet to over 500 vessels (with or without personnel aboard), with small surface combatants—which include the LCS—comprising 66 ships in the fleet.

[23]In its proposed William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, the House of Representatives included a provision prohibiting the Navy from decommissioning the USS *Fort Worth* (LCS-3) and the USS *Coronado* (LCS-4) until the Secretary of the Navy has submitted a certification that all operational tests have been completed on all mission modules. The provision was not enacted in the final law. *See* H.R. Rep. No. 116-617, at 1753 (Dec. 3, 2020).

awarded contracts to build the remaining ships and expects delivery between 2021 and 2025.

After the shipbuilder delivers the ship to the Navy, the ship is commissioned—marking a ceremonial acceptance of the ship to the operating force. Once the ship has completed its post-delivery period, it is provided to the operational fleet, which generally coincides with a milestone known as the obligation work limiting date. In this report, we use the obligation work limiting date as the delivery date of the ship to the fleet. At that point, the ship generally enters the sustainment phase and is ready either to deploy or to perform its mission in a training exercise or in operations away from its homeport. As more ships are delivered and enter the sustainment phase, O&S costs will continue to increase. Thus far in the program, the Navy has reported total O&S costs for the seaframes of approximately $2.5 billion. See figure 4 for information on the Navy's planned schedule for the LCS.

Figure 4: Planned Delivery Schedule and Operating and Support Costs of Littoral Combat Ships (LCS), as of March 2021



Source: GAO analysis of Navy documentation. | GAO-22-105387

Note: For the purposes of this report, we are using the obligation work limiting date—when the ship is provided to the operational fleet—as the delivery date of the ships. This milestone occurs after the ship has been commissioned.

[a]Total operating and support (O&S) costs are provided in millions of dollars for the seaframes that have been delivered to the fleet.

[b]Pursuant to Navy guidance, there is no requirement for LCS-1 USS *Freedom* and LCS-2 USS *Independence* to have a work obligation limiting date—when the ship is provided to the operational

fleet—because these ships were constructed using Research, Development, Test, and Evaluation funding.

Prior GAO Work on Cost, Schedule, and Performance of the LCS Program

As we have previously reported, the LCS has experienced cost overruns, schedule delays, and performance issues since the beginning of the program. For example, in 2016 we testified that LCS cost, schedule, and capability expectations had eroded over time. The Navy attributed this series of engineering failures on delivered LCS to shortfalls in crew training, seaframe design, and construction quality.[24]

The Navy originally expected to reach initial operational capability for both seaframe variants and the mission modules by 2010. [25] However, the *Freedom* variant and the *Independence* variant reached initial operational capability in 2014 and 2015, respectively. According to Navy officials, as of February 2021, the Navy had not reached initial operational capability for two of the three mission packages.[26]

In July 2014 we found that the Navy had not yet addressed existing risks in executing key concepts such as filling positions, training, and maintenance.[27] In December 2015 we reported that the lethality and survivability of the ships was unproven. Further, the Navy did not have plans to address these issues while moving forward with purchasing

[24]GAO, *Littoral Combat Ship and Frigate: Slowing Planned Frigate Acquisition Would Enable Better-Informed Decisions*, GAO-17-279T (Washington, D.C.: Dec. 8, 2016).

[25]Initial operational capability is a key milestone in weapon system acquisitions that typically refers to the time when the warfighter (in the Navy's case, the operational fleet) has the ability to employ and maintain a new system.

[26]The Navy reached initial operational capability for three of the four mission modules within surface warfare in 2014. According to officials, as of February 2021 the Navy had not reached initial operational capability for the mission modules within anti-submarine warfare and mine countermeasures missions.

[27]GAO-14-447. We also previously reported that the Navy often validated sustainment assumptions contained in sustainment planning documents without evaluating those assumptions and identifying key areas of risk, even when programs introduced new sustainment concepts. See GAO-20-2.

additional ships.[28] We also reported that current O&S estimates were significantly higher than the initial estimates, because the Navy did not account for sustainment risks in its initial estimates, and those estimates were nearing or might exceed those of other surface ships, including larger ships and ships with larger crews.[29]

The Navy Has Implemented Most Recommendations from Its 2016 Review but Faces Maintenance Challenges

The Navy has implemented eight of the 10 recommendations from its 2016 Review. It has also taken steps to revise its maintenance approach by replacing contractors with Navy personnel to conduct maintenance on the seaframes. But the Navy is facing challenges in implementing this approach, such as determining the proper number of maintenance teams; defining their necessary missions, functions, and tasks; determining how to obtain technical data that Navy personnel will need to perform these tasks; and determining the degree to which maintenance teams can feasibly be used to fill LCS crew vacancies.

The Navy Has Implemented Crewing, Filling Positions, and Training Recommendations from Its 2016 Review

The Navy has implemented eight of the 10 recommendations from its 2016 Review related to LCS crewing and filling positions, among others. The Navy is in the process of implementing the remaining two recommendations (see table 2).

[28]GAO, *Littoral Combat Ship: Knowledge of Survivability and Lethality Capabilities Needed Prior to Making Major Funding Decisions,* GAO-16-201 (Washington, D.C.: Dec.18, 2015).

[29]GAO-14-447; and GAO-20-2.

Table 2: Status of Recommendations from the 2016 Littoral Combat Ship (LCS) Program Review

Recommendations	Status
All LCS forward deploy in Blue/Gold rotational crewing construct Two crews (Blue crew and Gold crew) to rotate to the same ship every 4 to 5 months	implemented
Single crewing pre-commissioning unit seaframes Pairs a single crew with a ship in construction for 18 months	implemented
Merge the core crew and mission modules crew Merges the core 50-person crew with the mission module crew, creating a 70-person crew focused on a single mission area, supporting anti-submarine warfare, mine countermeasures, or surface warfare	implemented
Enhance forward liaison element in Singapore Provides maintenance support to LCS that are deployed to the 7th Fleet area of responsibility in Singapore	implemented
Establish a Commander, Naval Surface Force, U.S. Pacific Fleet (CNSP) N48 LCS/mine countermeasures (MCM) directorate Supports the daily management of maintenance and ship material readiness	implemented
Lengthen crew turnover periods to 2 weeks forward Extends the turnover period to 2 weeks; allows for additional time for the oncoming crew to enhance its situational awareness	implemented
Initiate pilot for O-6 (Captain) assessments during forward crew rotations Informs the immediate supervisor-in-command and commanding officers during crew rotation of the capability of the ship and crew, including knowledge of the actual performance and material condition of the ship	implemented
Testing ships: transition first four LCS as dedicated Continental U.S. (CONUS)-based testing ships[a] Testing ships are required to support development and operational testing of mission packages to limit the impact of such testing on deploying ships	implemented
Establish and resource the LCS maintenance teams[b] Teams to consist of Navy personnel to perform maintenance overseas while the LCS is deployed	in progress
Steady state: Blue/Gold-Plus rotational crewing with dedicated training ships Creates six four-ship divisions of the same variant, including a dedicated training ship to allow off-ship crews to complete training and certification while their ship is deployed	in progress

Legend: ✓ = Implemented, ➡ = In Progress

Source: GAO analysis of Navy documentation. | GAO-22-105387

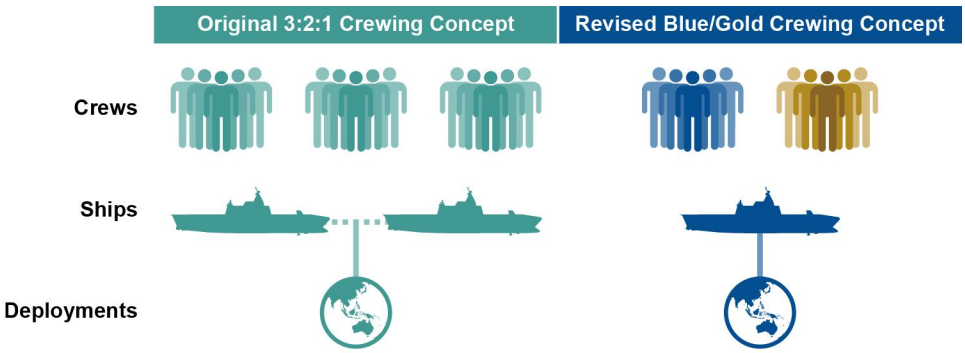
[a]The Navy has recommended the decommissioning of LCS-1 through LCS-4. In its proposed William M. (Mac) Thornberry National Defense Authorization Act for Fiscal Year 2021, the House of Representatives included a provision prohibiting the Navy from decommissioning the USS Fort Worth (LCS-3) and the USS Coronado (LCS-4) until the Secretary of the Navy has submitted a certification that all operational tests have been completed on all mission modules. However, the provision was not enacted in the final law. The Navy told us that, as of February 2021, these two ships remained on the deactivation list for decommissioning in March 2021. The status of these ships is pending.

[b]The Navy refers to these teams as maintenance execution teams.

Crewing. The Navy recommended in 2016 that two crews should be assigned and rotate to the same ship (recommendation 1). The Navy has implemented this recommendation by assigning two crews, known as Blue and Gold, to rotate to the same ship every 4 to 5 months. Navy officials said that the Blue/Gold rotations have helped crews develop a sense of ship ownership and have promoted crew cohesion. They also

said that the Blue/Gold rotations have enhanced maintenance continuity, because with two dedicated crews supporting one ship instead of three crews supporting two ships—the previous crewing concept—the same sailors will have an opportunity to become familiar with maintaining the same ship (see fig. 5).

Figure 5: Rotational Crewing for the Littoral Combat Ship



Source: GAO analysis of Navy documentation. | GAO-22-105387

In addition, the 2016 Review recommended merging the crews of the seaframes (core crew) and the mission modules (recommendation 3). The Navy implemented this recommendation by merging each seaframe crew with the crew for its assigned mission modules to create one combined crew of about 70 sailors. According to Navy officials, the formerly separate seaframe and mission module crews no longer rotate independently of one another. Navy officials told us that merging the crews has simplified the crew rotation process by adding capacity and creating crew stability to support deployments.

Filling positions. According to Navy officials, implementing the recommendation to merge the crews of the seaframes and mission modules will also help to meet position filling requirements.[30] In the past, when an unexpected vacancy occurred, the Navy re-assigned sailors from pre-commissioning crews to fill positions.[31]

Navy officials acknowledged to us that although the LCS that have deployed since 2019 have met their requirement of filling positions aboard

[30]Every LCS sailor is considered a “hybrid” sailor who must be qualified across multiple competencies to support LCS’s optimal construct of filling positions and meeting mission. This results in the core crew position filling requirement’s being 100 percent.

[31]The pre-commission crew are the sailors serving on pre-commissioned ships.

the ship prior to deployment, challenges remain. Specifically, in written responses, one squadron stated that the primary challenge in filling positions on the LCS is that there is a limited number of available sailors trained in skills unique to the LCS who qualify to fill the vacancies. Each crew member on an LCS requires multiple skills and performs multiple functions, such as specific maintenance duties, standing watch, and other tasks associated with a position. For example, an engineman whose primary duty is to operate, service, and repair engines must also have the skill to manage hazardous materials. As a result, it can be challenging to find a replacement. In written responses, one LCS squadron stated that several vacancies arose on two deployed ships in 1 year; the other squadron also experienced vacancies on one of two deployed ships in that year. Navy officials told us that filling those vacancies on deployment was dependent on whether the position was necessary for continued operation of the ship and whether coverage could be provided by another crew member.

Training. In response to the 2016 Review, the Navy has taken steps to implement a recommendation dedicating six LCS to train sailors when they are not deployed (recommendation 10). Navy officials told us that they have identified the first four of these training ships, with two at each homeport (San Diego and Mayport), and have started to conduct training on these ships. The shipbuilders have not yet delivered the remaining two training ships, which the Navy is expecting in 2021 and 2022. A high ranking Navy official has stated that the sailors' positions on these dedicated training ships will be filled by a single crew comprised of experienced LCS sailors who will be charged with training and certifying the remaining six crews assigned to their division.[32]

The Navy has also developed training courses, events, and exercises to support crews assigned to the LCS. Many of these training events are designed to support the missions assigned to each individual ship. Prior to recent deployments, squadron officials told us they determined LCS crews were sufficiently trained and prepared before they deployed. Further, in January 2020 the Navy issued its *Surface Force Training and Readiness Manual*, which provides training requirements, training

[32]Statement from Vice Adm. Tom Rowden, Commander, Naval Surface Forces, *Results from the Chief of Naval Operations Directed 60-Day Review of the Littoral Combat Ship Program* (Sept. 8, 2016).

concepts, basic training strategy, and information about mission area certification for the LCS.[33]

The Navy continues to take steps to address training for LCS crews, such as completing the LCS training facilities in Mayport, Florida, and San Diego, California, which Navy officials told us would eventually provide 85 percent of crews' training requirement by spring of 2021. The facility in San Diego is operational, and as of fiscal year 2017 crews were able to complete 55 percent of their training. According to Navy officials, crews currently attend training courses provided by a contractor to make up the remaining 30 percent. Navy officials told us they planned to have the training facility in Mayport fully operational by the end of fiscal year 2021. LCS crews are expected to complete their remaining training and certification on a dedicated LCS training ship.

Maintenance Teams Are Planned to Replace Some Contractor Maintenance, but Navy Is Facing Challenges in Implementing This New Approach

The Navy has taken steps to revise its maintenance approach to address its recommendation related to establishing and resourcing its maintenance teams from the 2016 Review (recommendation 9), but it is facing challenges in implementing this approach. We found that the Navy is facing challenges in implementing its maintenance approach for the seaframes, such as determining the proper number of maintenance teams; defining their necessary missions, functions, and tasks; determining how to obtain technical data that Navy personnel will need to perform these tasks; and determining the degree to which maintenance teams can feasibly be used to fill LCS crew vacancies.

The Navy's approach for maintaining the seaframe is to rely primarily on contractors who have the requisite knowledge and skills.[34] Contractors

[33]Navy, COMNAVSURFPAC/COMNAVSURFLANT Instruction 3502.7A.

[34]This maintenance approach was intended to be similar to that of the F-35 program, which also relies heavily on contractors to provide sustainment support. Specifically, Lockheed Martin integrates sustainment support for the aircraft system, depot maintenance, and pilot and maintainer training, as well as provides engineering and technical support. See GAO- *F-35 Aircraft Sustainment: DOD Needs to Address Challenges Affecting Readiness and Cost Transparency*, GAO-18-75 (Washington, D.C.: Oct. 26, 2017).

serve on fly-away teams that travel overseas to perform maintenance, as needed, to ensure that LCS crews can carry out their missions while deployed. However, in the 2016 Review the Navy recommended establishing and resourcing maintenance teams in order to use Navy personnel to perform maintenance on the seaframes while they are deployed.[35] Program managers told us that contractors, including original equipment manufacturers, will continue to maintain the mission modules.

The maintenance team concept is not new: maintenance teams already existed as groups of permanently assigned but nondeployed LCS crews, reservists, and other personnel who were available between training commitments. Their primary role was to assist at the Navy's regional maintenance centers and perform administrative tasks, such as completing work authorization forms for maintenance performed by contractors, to help minimize the time spent by LCS crews in completing these tasks. However, the Navy is taking steps to expand the role of the maintenance teams so that they perform some organizational-level maintenance, such as corrective maintenance and repairs attributed to general wear and tear, on the seaframes while underway.[36]

This type of maintenance is already performed by crews on other classes of ships. Maintenance teams may also be expected to perform some intermediate-level maintenance on the seaframes at the Navy's regional maintenance centers as well as facilities maintenance, such as industrial cleaning and corrosion control.[37] The Navy expects to complement this maintenance approach by enhancing the role of the forward liaison element in Singapore. This element will perform in-theater organizational-level maintenance and will monitor ship and equipment readiness, among other tasks.

Number of maintenance teams. According to Navy officials, the Navy allocated funding for the maintenance teams in fiscal year 2020, with

[35]The Navy refers to these maintenance teams as maintenance execution teams.

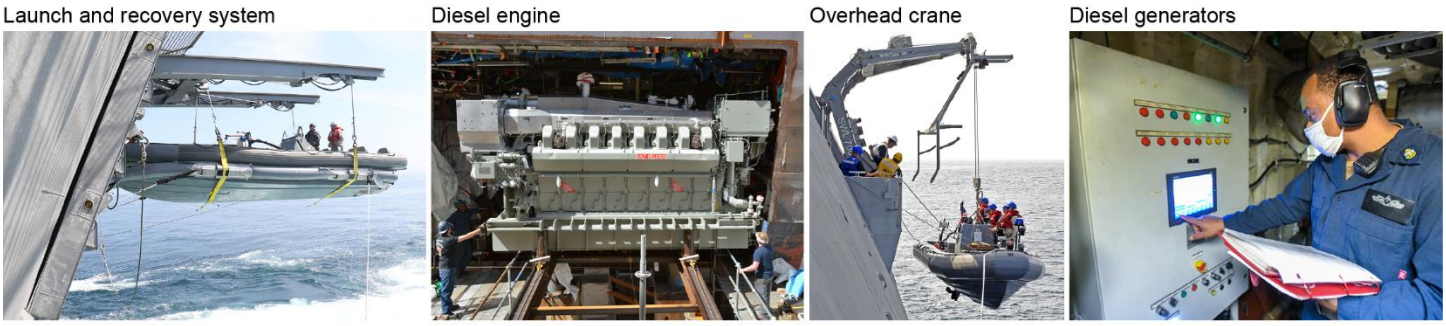
[36]Organizational-level maintenance is maintenance that is the responsibility of and performed by the crew on the ship on its assigned equipment. It normally consists of inspecting, servicing, lubricating, adjusting, and replacing parts, minor assemblies, and subassemblies.

[37]Intermediate-level maintenance is maintenance that is the responsibility of and performed by designated maintenance activities, such as the Navy's regional maintenance centers. It normally consists of calibration, repair, or replacement of damaged or unserviceable parts, components, or assemblies; the emergency manufacture of nonavailable parts; and the provision of technical assistance.

plans to begin filling these positions starting in fiscal year 2021. However, differences exist among Navy organizations as to when the maintenance teams will be fully established. According to Navy officials at the surface warfare division of the Office of Naval Operations, the Navy will continue to add maintenance teams through fiscal year 2024. However, according to officials at Naval Surface Forces Pacific, the Navy maintenance teams will not be fully established until fiscal year 2026. In addition, Navy leadership and the fleet are not in agreement as to how many new maintenance teams the Navy will establish and how many positions it will fill.

Missions, functions, and tasks. The Navy has not determined the missions, functions, and tasks the maintenance teams will perform, including the specific maintenance responsibilities the maintenance teams will assume from contractors. According to the Navy's original plan, contractors--including original equipment manufacturers--would perform the majority of the maintenance on several critical systems, such as the ship's launch and recovery system, diesel engines, overhead cranes, and diesel generators (see fig. 6).

Figure 6: Examples of Littoral Combat Ship Critical Systems Maintained by Contractors



Sources (left to right): U.S. Navy/Fire Controlman 1st Class Christopher J. Bright, Cassandra Eichner, U.S. Navy/Petty Officer 2nd Class Brenton Poyser, and U.S. Navy/Mass Communication Specialist Seaman Juel Foster. | GAO-22-105387

According to Navy officials' estimates, maintenance teams will conduct 95 percent of organizational and intermediate maintenance currently performed by contractors on seaframes, but these officials did not specify whether this was based on total costs or labor hours. This ratio may not be feasible because contractors, including original equipment manufacturers, perform the majority of the maintenance on several critical systems. The Navy's 2016 Review states that further study is required for establishing the maintenance teams to determine their missions, functions, and tasks; however, the Navy has not yet conducted this study.

Technical data. According to Navy officials, having maintenance teams maintain critical systems will require the Navy to gain access to some of the contractors' proprietary technical data for key systems, including the ships' gas turbine engines, steering systems, electric start systems, radar system, waterjets, some corrosion prevention systems, and life rafts. We previously reported that DOD should include weapon system considerations, such as access to technical data (i.e., product specifications) and computer software (i.e., source code), to its sustainment and engineering plans.[38] As part of its longer-term actions in response to the recommendations from the 2016 Review, the Navy is planning to improve its capability to repair critical systems at the regional maintenance centers by investing in training (i.e., sending Navy maintainers to original equipment manufacturers' service technician courses) and technology (i.e., special tools and diagnostic hardware and software).

During the acquisition of a weapon system, DOD makes decisions about the extent of technical data it will acquire. As part of that decision-making process, DOD can negotiate for license rights, and not ownership, of technical data or computer software to be delivered under a contract.[39] However, the Navy's original approach for maintaining the seaframe was to rely primarily on contractors. Navy officials told us that they do not have access to some of the technical data necessary to perform maintenance on the ships' critical systems and have not determined how they will obtain these requisite technical data from existing contractors. Navy officials at one of the regional maintenance centers told us that contractors will continue to perform depot-level maintenance on the seaframes at these centers.

Filling vacancies. The Navy has not determined the degree to which maintenance teams can feasibly be used to fill LCS crew vacancies, as stated in the 2016 Review. The Navy plans to use maintenance teams as a reserve pool for unexpected vacancies. In a joint statement before the Senate Armed Services Committee, the Assistant Secretary of the Navy for Research, Development, and Acquisition and the Commander of Naval Surface Forces stated that the maintenance teams would serve

[38]GAO, *Weapon System Sustainment: DOD Needs to Better Capture and Report Software Sustainment Costs*, GAO-19-173. (Washington, D.C.: Feb. 25, 2019).

[39]DOD 5010.12-M; and Defense Federal Acquisition Regulation Supplement (DFARS), § 252-227-7014.

both to relieve crew members from the tasks of "shadowing" contractors for force protection,[40] security, and safety purposes, and to provide trained personnel to fill unexpected vacancies.[41]

According to squadron officials, though, using the maintenance teams to fill such vacancies may create challenges. For example, squadron officials stated that it may be difficult to find a qualified replacement on a maintenance team to support specific LCS responsibilities. One of the squadrons reported unexpected vacancies each year from 2012 through 2020, and stated that each replacement sailor needed to be qualified to perform more than one type of task. In one division, for example, a gunner's mate—who is responsible for the operation and maintenance of the guided missile launching system and other weapon systems—also needs to be qualified as a maintenance and material management system coordinator. The Navy has not yet conducted the study for the maintenance teams, as required by the 2016 Review, which should include using these teams as a reserve pool for unexpected vacancies.

Navy officials stated in October 2020 that they had initiated a new 60-day review of key aspects of the LCS program, including the duties, roles, and maintenance responsibilities of the maintenance teams and contractors, among other things. However, as of February 2021, Navy officials told us they had not issued the results of this review. Also, they had created an LCS Strike Team to review seaframe sustainment issues, among other topics.

DOD guidance requires that the military services take action on recommendations from reviews.[42] Also, *Standards for Internal Control in the Federal Government* calls for management to monitor the findings

[40]Shadowing refers to crew members physically following contactors around the ship as they perform maintenance tasks such as changing batteries and cleaning filters, among other tasks.

[41]*Littoral Combat Ship, Hearing Before the Senate Armed Services Committee*, 114th Cong. (Dec. 1, 2016) (statement by Asst. Sec. of the Navy (Research, Development and Acquisition) Sean J. Stackley and Commander, Naval Surface Forces Vice Admiral Thomas S. Rowden). DOD defines force protection as preventive measures taken to mitigate hostile actions against DOD personnel (to include family members), resources, facilities, and critical information.

[42]DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense (IG DOD) and Internal Audit Reports* (Dec. 18, 2014) (incorporating change 1, Jan. 31, 2019).

and recommendations from reviews and to address findings and recommendations that warrant management action.[43] However, in addressing its recommendation related to establishing and resourcing the maintenance teams, Navy leadership and the fleet are not in agreement as to how many new maintenance teams the Navy will establish, and how many positions it will fill. Also, the Navy has not determined the specific types of maintenance to be performed by the contractors and maintenance teams, and it has not determined how it will obtain requisite technical data from existing contractors. Lastly, the Navy has not yet conducted the required study to determine how to include using these maintenance teams as a reserve pool for unexpected vacancies on the ships.

Until the Navy conducts a study to determine how many teams and positions to establish, what tasks they will perform, how to obtain requisite technical data from existing contractors, and how to use these teams to fill vacancies, the Navy remains at risk of not being able to meet the maintenance needs of the LCS.

The Navy's LCS Cost Estimates Do Not Account for Revised Maintenance Approach and Are Incomplete and Inaccurate

The Navy's cost estimates for the seaframes do not account for the cost implications of its revised maintenance approach. Additionally, the Navy has not updated some cost estimates—the program life-cycle cost estimates and the currently required Selected Acquisition Reports—to reflect these revised concepts, and it has not incorporated actual cost

[43]GAO-14-704G.

data.[44] Further, we found that some of the O&S-reported actual cost data for the mission modules program are incomplete and inaccurate.

The Navy Has Not Assessed the Cost Implications of Its Revised Maintenance Approach

As we previously discussed, the Navy has taken steps to implement a revised maintenance approach for the LCS whereby maintenance teams filled by Navy personnel perform preventive and corrective maintenance on the seaframes. Our analysis found that there are a number of cost categories, such as personnel, travel, and contractor support, for which the Navy can anticipate that implementing the maintenance teams would affect future O&S costs.[45] The 2016 Review identified areas for further study, including assessing the potential benefits and costs associated with implementing the maintenance teams. However, the Navy has not assessed the cost implications of this revised maintenance approach. As stated previously, Navy officials told us that in October 2020 they initiated a new 60-day review of key aspects of the LCS program, including the revised maintenance approach, and that this review may include cost information related to this revised approach.

According to Navy officials, as maintenance responsibilities are transitioned from contractors to maintenance teams, the costs for paying contractors to perform this work should eventually decrease. Reductions in contractor maintenance costs could have important implications for future O&S costs. Our analysis shows that maintenance costs accounted for $1.5 billion (62 percent) of the total $2.5 billion O&S costs for the seaframes from fiscal years 2009 through 2019.[46] Maintenance performed

[44]Selected Acquisition Reports are currently statutorily required quarterly comprehensive reports submitted to Congress that include cost, schedule, and performance updates as compared with the acquisition baseline on major defense acquisition programs. 10 U.S.C. § 2432. The National Defense Authorization Act for Fiscal Year 2018 terminated several DOD reporting requirements, including the requirement for Selected Acquisition Reports, effective December 31, 2021. Pub. L. No. 115-91, § 1051 (2017). The National Defense Authorization Act for Fiscal Year 2020 directed the Secretary of Defense to submit a proposal for an alternative methodology for reporting on all acquisition programs. Pub. L. No. 116-92, § 830 (Dec. 20, 2019). DOD submitted a proposal in November 2020, but as of March 2021, DOD officials had not provided information on a replacement product.

[45]In September 2020 the Navy started testing its maintenance teams' concept by using the USNS *Burlington* to transport sailors and their equipment and repair material to various LCS for scheduled maintenance that could increase the cost of implementing the revised maintenance concept.

[46]See appendix V for additional information on O&S costs for the LCS program.

by the maintenance teams will likely be reflected within the unit-level personnel cost category of O&S costs, which will likely increase. At the same time, there may also be costs associated with moving maintenance responsibilities from contractors to maintenance teams. For example, the Navy may incur additional costs in the level of training needed to repair key components of the seaframes.

We analyzed available O&S cost data for the LCS and identified areas in which costs would be likely to increase, at least temporarily, as a result of the revised maintenance approach. For example:

- Navy officials told us that during the planned transition to the maintenance teams, both contractors and Navy personnel will simultaneously perform the same maintenance tasks while the contractors train the maintenance teams. Increased maintenance performed by the maintenance teams will likely be reflected within the unit-level personnel cost category of O&S costs, which will likely increase.[47] Even in advance of the planned transition to the maintenance teams, the Navy's unit-level personnel O&S costs for LCS have been increasing. For example, unit-level personnel costs rose by $31.9 million between fiscal years 2018 and 2019 (from $122.3 million to $154.2 million), which represents a 26 percent increase relative to fiscal year 2018.
- Contractors currently travel overseas to conduct routine maintenance when LCS are deployed. According to Navy officials, the LCS requires more travel by fly-away teams to perform maintenance than do other ship classes, because of the ship's small crew.[48] Estimated travel costs can vary from a few thousand to millions of dollars per contract. Each LCS requires multiple maintenance events per deployment. While the Navy implements maintenance teams over the next several years, maintenance teams will also travel to the ships to perform maintenance. Navy officials told us they do not know how travel costs will be affected over the next 5 years as they transition to the maintenance teams. They said that once the maintenance teams are fully implemented they will be stationed in port to perform

[47]The Navy defines this cost element as unit-level manpower. In this report we are referring to it as unit-level personnel, which includes military personnel, and does not include civilian or contractor costs related to personnel.

[48]The 2016 Review states that a hybrid maintenance strategy is employed on LCS due to the reduced LCS crew size. The hybrid maintenance strategy relies on the crew, off-hull support, and contractors to perform the maintenance workload that is traditionally performed by the crew.

maintenance on the seaframes of the LCS homeported there. However, Navy officials stated that they expect the maintenance teams to continue to travel to the location of the LCS until additional LCS are deployed on a consistent basis and it becomes cost effective to permanently station maintenance teams at foreign ports.

The 2016 Review recommended that the Navy reduce its reliance on contractors by establishing the maintenance teams and that it should assess the costs and potential benefits associated with establishing and resourcing the maintenance teams.[49] According to DOD guidance, a comprehensive analysis, such as a business case analysis, of alternatives should identify the costs, benefits, and risks of these alternatives and evaluate them.[50] The analysis can be used to validate any proposed scope, schedule, or budget changes and to inform program decision-making.

However, the Navy has not assessed the cost implications of its revised maintenance approach for the LCS seaframes on future O&S costs. Without such an assessment, the Navy lacks a clear picture of the near- and long-term impact of maintenance teams on future O&S costs. Such information would be valuable for future decisions about the LCS program, as well as for Navy-wide decisions about allocation of resources.

Navy Has Not Updated Some Estimates to Reflect Revised Operational and Sustainment Concepts and Has Not Incorporated Actual Cost Data

Since the seaframes and the mission modules constitute two separate major defense acquisition programs, the Navy develops separate cost estimates for the seaframes and the mission modules.[51] The Navy develops program life-cycle cost estimates and prepares comprehensive annual estimates and subsequent quarterly updates of O&S costs in its Selected Acquisition Reports to Congress. We found that, in some cases, the Navy had not updated these estimates to reflect the revised

[49]Department of the Navy, Chief of Naval Operations, Littoral Combat Ship Review Team Report (May 17, 2016).

[50]DOD, *DOD Product Support Business Case Analysis Guidebook* (2011) (updated March 2014).

[51]When we refer to the estimates for mission modules, we are referring to the mission module program as a whole and not the 12 individual mission modules.

operational sustainment concepts and had not incorporated actual cost data.

Mission Modules Cost Estimates

Program life-cycle cost estimates. The Navy updated its mission module program life-cycle cost estimate in 2018. Our review of that estimate found that the Navy had incorporated the revised operational and sustainment concepts, including changes to rotational crewing, to training, and to the operational and warfighting capability of assigning modules to groups of ships focused on specific missions. Further, our review of the 2018 program life-cycle cost estimate for the mission modules showed that the Navy used actual cost data to update the estimate. In updating the cost estimate, the Navy used actual O&S costs for the mission modules within the surface warfare mission. For example, the Navy used actual costs to support the mission modules within the surface warfare mission (gun mission module and surface-to-surface mission module) from fiscal years 2015 through 2017.

Selected Acquisition Reports. Our analysis of the reports for the mission modules program, which incorporate changes in operational and sustainment concepts, showed a 35 percent increase in the annual O&S costs for fiscal years 2016 through 2019. According to Navy officials, this increase is due to changes it had implemented in response to the 2016 Review as well as to other factors, such as updates to its cost methodology and replacing and increasing the number of systems for the mission modules. With regard to whether actual O&S costs were included in the O&S estimate, the Selected Acquisition Report for fiscal year 2018 contained a statement specifying that it included data from the VAMOSC database for cost estimating relationships. It is unclear, however, whether these data pertained to the mission modules or to similar weapon systems.[52] The remaining Selected Acquisition Reports for fiscal years 2015 through 2017 and for 2019 do not include a statement that these estimates include actual O&S cost data.[53]

[52]The Navy collects, tracks, and reports O&S costs in its Visibility and Management of Operating and Support Costs (VAMOSC) database.

[53]While the mission modules program produced Selected Acquisition Reports prior to fiscal year 2015, for this analysis we assessed whether actual costs were incorporated after initial operating capability, which was achieved in 2014 for three of the four mission modules within the surface warfare mission—i.e., gun mission module, maritime security mission module, and the aviation mission module.

Our review of these reports shows that actual O&S costs may not have been used to update these estimates. For example, we found that there were no changes in O&S costs between the 2018 and 2019 Selected Acquisition Reports, while our analysis of the VAMOSC database showed different costs for these fiscal years. Program officials told us that they were unsure as to whether actual O&S costs were used to update these cost estimates and confirmed that there were no differences in the O&S cost estimates between fiscal years 2018 and 2019.

Seaframe Cost Estimates

Program life-cycle cost estimate. The Navy has not updated its seaframe program life-cycle cost estimate since 2011, and that estimate does not reflect revised operational and sustainment concepts from the 2016 Review.[54] The significant changes in crewing the LCS, training the crew, and maintaining the seaframes have important implications for the seaframes' life-cycle cost estimates. Additionally, the 2011 program life-cycle cost estimate for the seaframes does not reflect actual cost data, in that only one ship had been commissioned and O&S costs were not available when this estimate was prepared.[55] This estimate was based on comparisons of analogous large surface ship classes, such as the destroyer.

Selected Acquisition Reports. Our review of the O&S cost estimates within the Selected Acquisition Reports for the seaframes indicates that they do not reflect all of the revised operational and sustainment concepts that have been developed since the 2016 Review. Navy officials told us they updated these O&S cost estimates to account for the revised operational and sustainment concepts, such as the Blue and Gold crewing concept. However, our analysis shows that not all factors, such as the cost for the maintenance teams, may be accounted for in the estimates. In the documentation provided by the Navy, the 2016 Selected Acquisition Report O&S cost estimate was adjusted to account for the Blue and Gold crewing concept, lethality and survivability upgrades, and updated maintenance requirements. The adjustments made to account

[54]Typically, a revised program life-cycle cost estimate is created at certain milestones to understand whether there is a sound basis to continue the program. However, the Navy did not produce a revised cost estimate for the seaframes for its milestone review in 2012 because this requirement was rescinded.

[55]We previously reported that the Navy had not updated its life-cycle cost estimates to reflect actual O&S costs across multiple ship classes such as amphibious, submarine, and surface ship classes like the LCS. See GAO-20-2.

for updated maintenance requirements impacted the maintenance cost element. If this estimate incorporated the cost for the maintenance teams, there would also be an adjustment made to personnel costs, among others, since there would be additional Navy personnel required to fill these positions.

The Selected Acquisition Report O&S cost estimates for the seaframes showed less than a 2 percent increase from the 2016 to the 2019 cost estimate, despite the Navy's increasing the number of crews by approximately 10 percent (from 60 to 66) and increasing the number of seaframes by approximately 9 percent (from 32 to 35) over this time period (see table 3 below).[56] In addition to the increases in the number of crews and seaframes, other concepts--such as the maintenance teams and required training implemented as a result of the 2016 Review--would also impact costs. Based on our analysis of these reports, we found that the Navy did not incorporate the cost implications of all the revised operational and sustainment concepts. With regard to whether actual O&S costs were included in the O&S estimate, the Navy's Selected Acquisition Report O&S cost estimates for the seaframes included a statement in each of the reports for fiscal years 2015, 2016, 2018, and 2019 that cost data from the VAMOSC database were updated for these O&S cost estimates. However, the report from fiscal year 2017 did not indicate that actual O&S costs from the VAMOSC database were updated.[57]

[56]The number of crews and number of seaframes is based on the data as reported in the Selected Acquisition Reports.

[57]While the seaframes produced Selected Acquisition Reports prior to fiscal year 2015, for this analysis we assessed whether actual costs were incorporated only after initial operating capability, which was achieved in 2014 (for the *Freedom* variant).

Table 3: Percent Differences between Operating and Support Cost Estimates in 2016 and 2019 Selected Acquisition Reports for the Littoral Combat Ship Seaframes

(Dollars in millions)

Category	2016 (Selected Acquisition Reports)	2019 (Selected Acquisition Reports)	Percent change
Unit-level personnel[a]	10.6	10.9	2.4%
Unit operations	10.1	9.6	-4.4%
Maintenance	18.0	18.5	2.4%
Sustaining support	4.2	4.2	0.1%
Continuing system improvements	10.4	11.0	6.1%
Indirect support	5.2	5.3	2.3%
Total per ship per year	**58.4**	**59.4**	**1.7%**
Total for the life of the program	**46,747.4**	**52,001.3**	**11.2%**
Number of crews	60	66	10.0%
Number of crew personnel	3,000	3,300	10.0%
Number of seaframes	32	35	9.4%

Source: GAO analysis of Navy data.| GAO-22-105387

[a]The Navy refers to this cost element as unit-level manpower.

As noted above, the mission modules program Selected Acquisition Reports incorporate changes to operational and sustainment concepts from the Navy's 2016 Review and show an increase in O&S costs of 35 percent in the 2019 report. While we would not expect the percent increase for the seaframes program to be the same as that of the mission modules program, we would expect to see an increase higher than 2 percent for the seaframes, to account for the increased number of crews and seaframes and other factors related to the revised operational and sustainment concepts. These factors raise questions about the completeness and accuracy of the Navy's cost estimates for seaframes.

The National Defense Authorization Act for Fiscal Year 2018 terminated the Selected Acquisition Reports requirement, effective December 31, 2021.[58] Also, the National Defense Authorization Act for Fiscal Year 2020 directed the Secretary of Defense to submit a proposal for an alternative methodology for reporting on all acquisition programs.[59] DOD submitted a

[58]Pub. L. No. 115-91, § 1051 (2017).

[59]Pub. L. No. 116-92, § 830 (Dec. 20, 2019).

proposal in November 2020, but as of March 2021, DOD officials had not provided information on a replacement product.

According to DOD guidance, after any weapon system reaches initial operational capability, estimated O&S costs must be updated annually throughout the program's life cycle to determine whether the preliminary information and assumptions used to develop the estimates remain relevant and to identify and record reasons for any variances.[60] Further, GAO's *Cost Estimating Guide* states that cost estimates should be regularly updated to ensure that they reflect changes to the program and incorporate actual cost data as they become available.[61]

Navy officials told us that they have not updated the program life-cycle cost estimate for the seaframes—either to reflect the revised operational and sustainment concepts or to incorporate actual cost data—because they have limited information from LCS deployments. However, the Navy has data on actual costs from three completed deployments or voyages that occurred between 2013 and 2017 using the initial operational and sustainment concepts. These data could provide a more meaningful point of comparison, even with the changes in operational and sustainment concepts, than is provided by the estimates from 2011, which are based on analogous large surface ship classes such as the destroyer. Further, Navy officials told us that they do not consider O&S cost information from LCS-1 through LCS-4 to be representative of the expected O&S costs for LCS-5 and subsequent ships, because the design of the first four ships differs from that of subsequent ships. Despite any differences, however, a revised estimate using actual costs would be more accurate than the Navy's initial estimate, which is based on analogous large surface ship classes such as the destroyer.

Updating cost estimates for the LCS would help the Navy plan for adequate resources to support the program. Updated cost estimates that reflect the revised operational and sustainment concepts and include all operating and support costs and actual data from completed LCS deployments would provide the Navy with the latest information on resource needs and would assist with decision making. As the LCS program collects more actual O&S costs, the accuracy of O&S cost estimates should improve, provided the Navy updates those estimates using actual costs and reflecting updated operational and sustainment

[60]DOD Instruction 5000.73.

[61]GAO-20-195G.

concepts. Without accurate cost estimates, the Navy is at risk of failing to anticipate O&S cost increases that could create challenges in funding LCS as intended, or in delivering capabilities at the time they are expected. If cost estimates do not provide complete information on the costs of implementing the revised operational and sustainment concepts and do not reflect data obtained from completed deployments, Congress does not know the extent to which the O&S cost estimates provide reliable insight into the future costs of the program.

Seaframe Cost Data Improved, but Some Mission Module Cost Data Are Incomplete and Inaccurate

As the Navy works to update LCS cost estimates, it should rely on the accuracy of its O&S cost data.[62] However, we found that the Navy is not reporting complete and accurate cost data for the LCS in its historical VAMOSC database. Our analysis of the O&S costs for the seaframes in VAMOSC shows that the Navy's cost data were initially incomplete. During our review of the data, we found that the Navy did not include unit-level personnel costs for the USS *Milwaukee* (LCS-5) and the USS *Detroit* (LCS-7) for fiscal year 2019. After we alerted the Navy to the missing data, the Navy updated these data in July 2020, and it has now provided complete and accurate O&S costs for the seaframes.

Our analysis of the O&S costs for the mission modules in VAMOSC shows that these data are incomplete. For example, for fiscal years 2015 through 2019, the Navy reported maintenance costs but no other O&S cost elements for the mission modules. According to Navy officials, the Navy is reporting only maintenance, which includes embarkation (installing mission modules on seaframes) and debarkation (removing mission modules from seaframes) costs for the mission modules. These officials told us that there were limited costs for O&S cost elements besides maintenance because most other costs incurred for the mission modules were related to developing, testing, and producing the mission

[62]The VAMOSC database reports actual costs incurred for LCS, which are reported through the program office. Cost estimates, such as the program life-cycle and Selected Acquisition Report O&S cost estimates, are developed separately through a specific methodology that relies on multiple sources, including actual costs when available. According to GAO's *Cost Estimating and Assessment Guide*, there can be challenges with cost estimating that can limit accuracy and following best practices to mitigate these challenges is important.

modules. Navy officials told us they plan to work with the Naval Center for Cost Analysis to populate all O&S costs in the VAMOSC database.

Additionally, in February 2021 program officials told us they would start reporting combined unit-level personnel O&S costs for the seaframes and mission modules because the crews have been merged. However, these officials also told us they did not yet know how they would accurately account for these costs so as not to double-count, since these two programs were initially expected to report their costs separately. See table 4 for Navy's reported O&S costs for LCS.

Table 4: Operating and Support Costs for Littoral Combat Ships

Dollars in millions[a]

Operating and support (O&S) cost elements	Seaframes (2009 – 2019)[b]	Mission modules (2015 – 2019)[c]
Unit-level personnel[d]	567.2	n/a
Unit operations	391.9	n/a
Maintenance	1,470.6	At least 136.9
Sustaining support	254.1	n/a
Continuing system improvements	187.5	n/a
Total	**2,871.3**	**Unknown**

Source: GAO analysis of Navy data. | GAO-22-105387

[a]The seaframe and mission module costs are in constant fiscal year 2019 dollars.

[b]The Navy commissioned the first LCS in 2008 and it started accruing O&S costs in 2009.

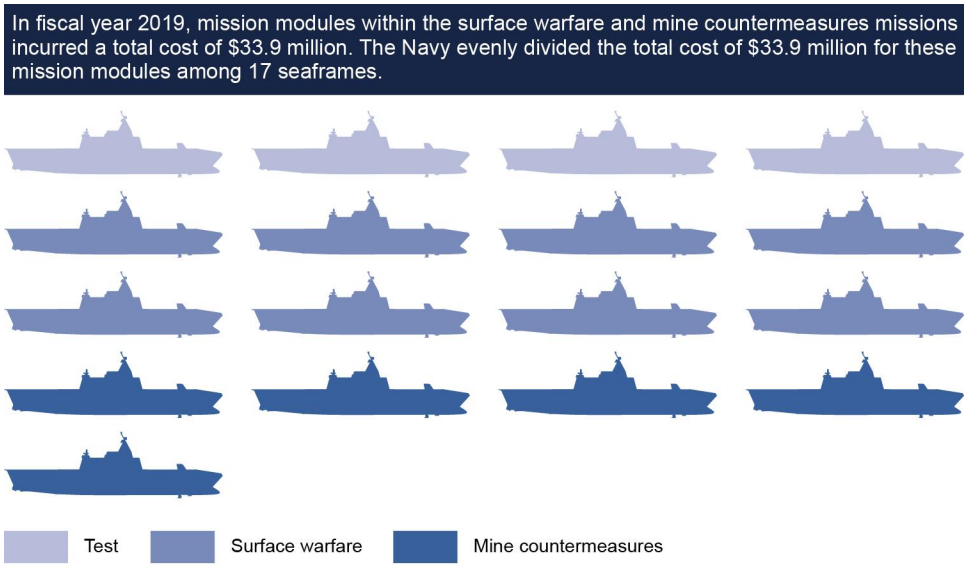
[c]The Navy's Visibility and Management of Operating and Support Costs (VAMOSC) database reported maintenance costs for the mission modules starting in 2015.

[d]The Navy refers to this cost element as unit-level manpower.

The Navy began reporting costs for the mission modules in its VAMOSC database in fiscal year 2015. Officials from the program office told us that the Navy does not report O&S costs until a system has reached initial operational capability, which was in 2014 for three of the four mission modules within the surface warfare mission—gun mission module, maritime security mission module, and aviation mission module. However, in our review of the 2018 program life-cycle cost estimate, we found that the Navy had underreported actual O&S costs for fiscal years 2015 through 2017. The VAMOSC O&S costs for this time period were $77.1 million (in fiscal year 2019 dollars), while the 2018 program life-cycle cost estimate showed that the total O&S costs for those same 3 years was $528.4 million (in fiscal year 2019 dollars).

The Navy's VAMOSC database also does not report accurate maintenance costs for the mission modules. We found that the Navy does not report maintenance costs separately for each mission module. Instead, it aggregates the maintenance costs for all of the mission modules and divides that figure by the number of seaframes in the fleet. As a result, costs for mission module maintenance are distributed evenly across all the seaframes in the fleet rather than assigned to the specific ship or mission module that incurred the cost (see fig. 7). For example, our analysis shows that the Navy reported the same mission module maintenance costs for each seaframe regardless of which mission modules were assigned to it, or whether it had any mission modules attached at all.

Figure 7: Distribution of Mission Module Maintenance Cost across the Fleet for Fiscal Year 2019



Source: GAO analysis of Navy data. | GAO-22-105387

In addition, the Navy attributed these costs to the seaframes regardless of their operational status, such that a deployed ship was reported to have the same mission module maintenance cost as a ship in storage or undergoing maintenance, for which a mission module or mission modules were attached, and 10 mission modules incurred costs in the VAMOSC database. Since these costs are allocated across the 17 seaframes, they do not accurately represent actual maintenance costs for each mission module.

DOD's guidance states that the Navy should ensure that it collects and reports complete and accurate O&S costs.[63] GAO's *Cost Estimating Guide* states that comparing cost estimates to actual costs is part of cost estimating best practice; that accurate estimates should examine any variances between estimated and actual costs; and that variances should be documented, explained, and reviewed.[64]

The Navy did not provide an explanation as to why it was reporting only maintenance costs for mission modules in VAMOSC. When the LCS program was initially developed, the Navy planned for mission modules to be interchangeable, allowing any mission module to be attached to any seaframe. This plan led to the Navy's practice of distributing maintenance costs for mission modules across all of the seaframes. However, these incomplete and inaccurate data prevent meaningful comparisons between estimates and actual O&S costs for the mission modules.

The Navy is making critical decisions about how to sustain the LCS without having complete and accurate cost data or the ability to compare the estimates to the actuals. Without reporting complete and accurate O&S cost data from VAMOSC for LCS mission modules on a per ship and per mission module basis, the Navy will not be able to analyze the differences between estimates and actuals to identify and mitigate critical risks to LCS. These risks may lead to unexpected increases in costs, and the Navy could find it more difficult to evaluate its operating and sustainment planning assumptions.

The Navy Has Not Demonstrated the Operational and Warfighting Capabilities the LCS Fleet Needs to Perform Its Missions

The Director, Operational Test and Evaluation, has reported on several significant deficiencies identified during operational testing of the seaframes, and four of the 12 mission modules have been developed,

[63]DOD Office of Cost Assessment and Program Evaluation, *Operating and Support Cost-Estimating Guide*; and Secretary of the Navy Instruction 7000.29A, *Naval Visibility and Management of Operating and Support Costs Program Data Collection* (Jan. 26, 2021).

[64]GAO-20-195G.

tested, and deployed.[65] We found that deployed LCS have encountered significant challenges during their deployments that have prevented them from carrying out their operational and warfighting missions.

DOT&E Has Identified Several Deficiencies during Testing

Deficiencies Identified in the Seaframes

Prior to and since 2016, DOT&E has reported several deficiencies that it found during operational testing of the seaframes and has made recommendations to address them. Some of these deficiencies are identified below. Except where otherwise noted below, as of December 2020 the Navy had not addressed these deficiencies or implemented some of DOT&E's recommendations.

- **Self-defense capabilities.**
  - **Torpedo and mine defense.** In 2019 the Navy conducted mine susceptibility testing on the *Freedom* variant seaframe. These tests utilized an advanced simulator to validate mine testing for both variants. However, the Navy encountered difficulties in executing the advanced simulator tests, and it completed one-third of planned mine defense trials. In addition, the Navy has not funded the torpedo capability for the seaframe, and thus it has not been tested. In 2020 DOT&E urged the Navy to prioritize accelerating the development of the torpedo defense capability for the *Independence* and *Freedom* variants.
  - **Combat systems.** The seaframes have different combat systems to provide command and control, situational awareness, and self-defense against surface craft. In 2016 DOT&E reported that the seaframe encountered problems on a regular basis in cooling the

[65]The Director, Operational Test & Evaluation (DOT&E) is within the Office of the Secretary of Defense and provides independent assessments on equipment and weapons, including software and cybersecurity, integrated test and evaluation, and modeling and simulation, among other things. DOT&E monitors and reviews operational testing and evaluation for all DOD programs and issues an annual report, which includes recommendations, on these tests and evaluations. These reports and recommendations are separate from the Navy's 2016 Review of the LCS program. We reviewed DOT&E reports on the LCS from fiscal years 2003 through 2020.

combat system, which required the Navy to reschedule testing and to conduct operations with reduced capability. In 2017 and again in 2019 DOT&E reported that it could not fully assess the operational effectiveness and suitability of the combat systems aboard either seaframe variant without further testing.[66] In 2019 DOT&E also reported that the Navy had suspended its work in developing the modeling and simulation suite of the LCS combat system because some of the system elements (e.g., radars) were not available. In its 2020 report DOT&E stated that the Navy had not restarted this effort. As a result, DOT&E recommended that the Navy resource the development of the modeling and simulation suite of the LCS combat system.

- **Air warfare systems.** The seaframes' air warfare systems provide self-defense to detect, track, and engage so-called low and slow flyers (i.e., aerial vehicles without personnel aboard, slow-flying fixed winged aircraft, and helicopters). In 2016 DOT&E reported that the Navy had postponed planned testing for the air warfare system because it predicted that the system would perform poorly under testing scenarios. In 2017 and again in 2019, DOT&E reported that the Navy did not plan to conduct further operational testing of these systems. In its 2019 and 2020 reports, DOT&E stated that the Navy had not resourced or conducted any air warfare testing against anti-ship cruise missiles as part of the systems' approved testing.

  DOT&E made several recommendations related to the air warfare systems, including for the Navy to (1) adequately fund the air warfare defense for further testing; (2) provide plans for air warfare defense to enhance the ships' self-defense; (3) develop a safe method to realistically test the ships' ability to counter low and slow flying aircraft; and (4) improve the air-search radar on the seaframes to support early detection of threats in order to increase the likelihood of survival against attack.

- **Operational suitability.** In 2016, after several years of discovering serious deficiencies during testing, DOT&E reported that it had sufficient data to declare the *Freedom* and *Independence* variants of the seaframe unsuitable for operational use as a result of continued

[66]We previously reported that the lethality and survivability of the LCS is largely unproven, and the Navy has lowered several survivability and lethality requirements and removed several design features—making the ship both less survivable in its expected threat environments and less lethal than initially planned. See GAO-16-201.

reliability issues.[67] DOT&E also reported that the seaframes had encountered multiple problems with main engines, waterjets, and communications. Additionally, DOT&E stated that until the Navy reduced the failure rates of mission-essential equipment and corrected their deficiencies, these problems would continue to prevent the ships from being operationally effective. For example, in 2020 several seaframes experienced engine failures during deployments that prevented them from completing their missions. DOT&E has made several recommendations to improve the operational suitability of the seaframes and has recommended that all deficiencies identified on one ship should be remedied on all ships.

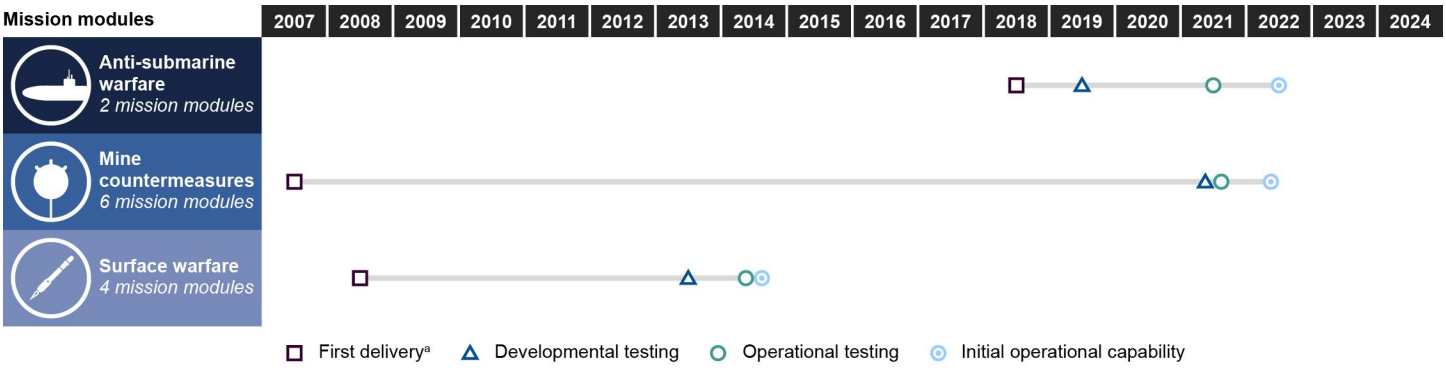
As of December 2020, Navy officials told us they had not addressed these deficiencies or the numerous recommendations made by DOT&E. Also, they said they have plans to address some of the recommendations from DOT&E and have taken action on some previous recommendations but have not addressed others. As a result, the seaframes continue to have unaddressed problems that hinder the ability of the LCS to carry out its operational and warfighting capabilities.

Few Mission Modules Have Been Developed, Tested, and Deployed

The LCS was expected to provide increased warfighting flexibility to the Navy fleet and to close gaps in surface, mine, and anti-submarine warfare missions. However, Navy officials told us that as of July 2021, the Navy had developed and tested the mission modules within the surface warfare (SUW) mission on both seaframe variants. Also, they said that the four mission modules within the SUW mission of the 12 total in the program have been developed, tested, and deployed (see fig. 8).

[67]We previously reported on the operational suitability of various ship classes when certain ships were delivered to the fleet, including the LCS. While we found that there are various interpretations of Navy policy about when ship classes should be operationally suitable, there is no clear determination in Navy policy of when ships should be operationally suitable, or even whether they ever need to achieve such a designation. See GAO, *Navy Shipbuilding: Policy Changes Needed to Improve the Post-Delivery Process and Ship Quality*, GAO-17-418 (Washington, D.C.: July 13, 2017).

Figure 8: Developmental and Operational Milestones for Mission Modules (as of July 2021)



Source: GAO analysis of GAO prior report, Department of Defense, and Navy documentation. | GAO-22-105387

[a]First delivery represents the delivery of some mission systems and support equipment in a mission module within anti-submarine, mine countermeasures, or surface warfare missions

Mission modules within surface warfare mission. According to officials from the LCS program office, the Navy has delivered the mission modules within the SUW mission. For example, in 2014 the Navy achieved initial operational capability by delivering the gun mission module, maritime security mission module, and aviation mission module; and in 2019 it delivered the surface to surface mission module. According to Navy officials, the mission modules within the SUW mission aboard the *Freedom* variant seaframes successfully fired their missiles, eliminated small boat targets, and completed operational testing. In its 2020 report, DOT&E stated that the mission modules within the SUW mission had completed a final testing event; however, the test was not considered representative of operations, because the Navy did not conduct the test in accordance with the DOT&E-approved test plan. Also, the DOT&E report stated that the Navy has not scheduled the final two small-boat defense operational tests required for the *Independence* variant because range time, targets, and ships were not available. According to the program office, additional testing is not required, and the office plans to finalize its report on the two small-boat defense-testing requirements.

Mission modules within mine countermeasures (MCM) mission: The mission modules within the MCM mission are behind schedule and have completed limited testing. According to Navy officials, as of January 2021 the Navy had delivered three of the six mission modules within the MCM mission—near surface detection, airborne mine neutralization, and coastal mine reconnaissance. The Navy is planning to conduct developmental and operational testing on the remaining mission modules

within the MCM mission in fiscal year 2021 and to reach initial operational capability in fiscal year 2022.

As we reported in June 2020, the Navy has reduced the requirements for the mission modules within the mine countermeasures mission and is planning to deploy these mission modules with potentially fewer capabilities than planned. Navy officials stated that the revised requirements focus on the ability of individual systems to communicate on an LCS rather than focus on addressing MCM mission module capability and technology challenges. The Navy has also tested and plans to continue testing the mission modules within the MCM mission on ships other than the LCS, known as vessels of opportunity, to demonstrate the capabilities of these mission modules.

Mission modules within anti-submarine warfare (ASW) mission. According to Navy officials, as of January 2021 the Navy had delivered the escort mission modules within the ASW mission and was procuring and producing several systems. For example, the Navy procured a sonar system in fiscal year 2020, and Navy officials told us they are expecting delivery of this system in fiscal year 2022. Also, in 2019 they began performing initial developmental testing of the mission modules within the ASW mission on the *Freedom* variant, with plans to continue testing through 2021.In 2019 DOT&E reported that it had no data that would allow it to make a preliminary assessment of the mission modules' operational effectiveness and suitability. In 2020 DOT&E stated that system reliability was a concern because of the observed failures throughout developmental testing. According to officials from the LCS program office, in 2019 the Navy completed testing of the variable depth sonar on a non-LCS ship to demonstrate the sonar's capability and validate its performance.

DOT&E has made several recommendations to address testing deficiencies across the mission modules. For example, DOT&E recommended that the Navy do the following:

- Consider developing additional capability for the mission modules within the SUW mission to effectively counter groups of small boats that are more representative of the threats they may encounter;
- Conduct ship-based testing for the mission modules within the mine countermeasures mission to reduce risks at sea, such as the ability to employ the tactics, techniques, and procedures in their expected

combat environments; and complete cybersecurity testing on the mission modules within the mine countermeasures mission; and

- Acquire sufficient quantities of torpedoes for anti-submarine warfare mission operational testing.

According to Navy officials, they have coordinated with DOT&E to implement recommendations to address deficiencies in the testing of the mission modules, and they plan to conduct cyber testing for the mission modules within the surface warfare mission on the *Freedom* variant in fiscal year 2021. However, these officials could not provide documentation to show that these recommendations had been implemented, or that they planned to address these deficiencies.

Additionally, the Navy's 2016 Review has a broader area to explore the testing requirements for the LCS. Specifically, the Navy is planning to develop a coherent approach to decrease the impact of seaframe and mission module testing on the operational schedule. According to the Navy, some of these testing requirements cause deployment delays or ships being pulled out of deployment rotations for as long as a year, and can be duplicative for mission module certification with each new increment. The Navy's 2016 Review stated that it plans to conduct a review to determine whether these testing requirements can be met in a more holistic approach that decreases their impact to LCS fleet operations.

LCS Has Encountered Significant Challenges during Deployments

Although the LCS has not met operational testing requirements, the Navy has deployed a limited number of ships to Singapore, the Caribbean, and South America. During these deployments, LCS crews have reported in lessons learned and post-deployment documents several significant challenges related to design, navigation, engine propulsion, and other operational issues. These deployments also showed challenges the LCS will face in providing adequate anti-terrorism and force protection while in port. Examples of these challenges are highlighted below.

- **Design challenges.** The *Independence* variant's design has caused docking problems in some foreign ports. The aluminum hull makes the ship susceptible to damage. For example, the crew of the USS *Coronado (*LCS-4) reported that the ship did not have adequate fenders (i.e., bumpers to prevent damage to the ship) to avoid contact

and sustaining damage during refueling. As the ship passed through the Panama Canal, the crew had to rely on fenders from steel-hulled ships for protection. The crew also reported that because of the design of the *Independence* variant, the hangar door does not fully close to provide the required watertight seal. Because these hangar doors do not have a watertight seal, the hangar bay (i.e., storage for equipment, weapons, and materials) can flood with water or fuel. Therefore, an extra team is needed to monitor the quarters in case of a fuel spill or flooding from water. According to Navy officials, the LCS currently meets the design requirement for the hangar door to provide a watertight seal.

- **Navigation challenges.** The LCS relies on electronic navigation and does not carry paper charts. However, because some of the ports and littoral areas through which the ships must navigate are not navigated frequently, the ships' electronic navigation systems may not have up-to-date data. The crew on the USS *Coronado* (LCS-4) reported that the ship did not have the most up-to-date charts for several ports of call during its deployment. The digital charts did not accurately reflect dangers in restricted waters.
- **Engine propulsion challenges.** The LCS has a complex transmission that connects power from two large gas turbine engines and two main propulsion diesel engines to the ship's propulsion shafts, which propel the ship through the water. Based on our assessment, this propulsion system has caused major challenges for LCS on deployments, with engine failures occurring on 10 out of 11 deployments to date. In 2013 the USS *Freedom* (LCS-1) experienced mechanical problems that hindered the crew's ability to operate the ship. These mechanical problems were due, in part, to problems with the ship's combining gear, the gear that allows the ship to run on a combination of diesel engines and gas turbine engines and thereby attain its maximum speed.

Follow-on ships also continue to experience engine issues. For example, in 2016 the USS *Fort Worth* (LCS-3) experienced a major propulsion issue during its initial deployment when the crew ran the combining gear without lube oil, thereby causing damage to the engine. Similarly, Navy officials told us, the USS *Milwaukee* (LCS-5) experienced propulsion issues on its initial voyage in 2015 from the construction shipyard to its homeport. As a result of these issues, the Navy suspended LCS deployments from December 2017 through May 2019. According to Navy officials, after resuming deployments, the USS *Detroit* (LCS-7) and USS *Little Rock* (LCS-9) both experienced major propulsion issues to their

engines in 2020, which rendered both ships inoperable. The Navy terminated both deployments early to perform repairs on these ships.

The *Independence* variant has also experienced engine propulsion issues. For example, in 2016 the USS *Coronado* (LCS-4) and USS *Montgomery* (LCS-8) both experienced major engine issues.

Navy officials told us that, as a result of these and other engine propulsion challenges, in January 2021 they notified Lockheed Martin—the shipbuilder of the *Freedom* variant LCS—that the Navy would not accept delivery of additional *Freedom* variant seaframes until Lockheed Martin fixed the problem with the combining gear, which affects the propulsion engine of the ship. Once developed, produced, and tested, the Navy plans to install this fix on ships already in the fleet.

- **Other operational challenges.** The LCS has experienced a number of other challenges on deployments that have affected operations. For example, the USS *Coronado* (LCS-4) crew stated that clogs in the Vacuum Collection Holding and Transfer system, caused by calcium buildup, had a severe impact on operational availability during its 2017 deployment. According to the crew, throughout the deployment they used hundreds of hours to keep the system operational, but eventually the calcium buildup was so severe that the mitigation procedures were inadequate to restore the system to operational condition. As a result, the crew had to return to Singapore to remove the calcium buildup from the system.

In another example, the crew of the USS *Coronado* (LCS-4) stated that the ship had failed to sail six times during its 2016 – 2017 deployment because it did not have the correct parts on board to fix simple problems. Specifically, circuit card assemblies, washers, bolts, gaskets, and diaphragms for air conditioning units were not on board, which caused undue delay to the ship's operational availability. The LCS may not have adequate space onboard to stock these items, and the Navy is re-evaluating how to position and manage materials and equipment while ships are deployed. According to Navy officials, in those instances they can grant waivers to ships to mitigate this challenge.

Also, according to Navy officials, when crew members are unable to locate parts for maintenance and repair of the ship, they "cannibalize" parts by taking them from another LCS. Officials at LCS squadrons in both San Diego and Mayport reported that cannibalization has occurred to support the ships. For example, the USS *Little Rock* (LCS-9) had a

faulty radar during its deployment, and the crew cannibalized a radar from the USS *Detroit* (LCS-7).

- **Force protection challenges.** With its small crew, the LCS has limited availability to provide force protection due to competing demands such as maintenance, shore patrol, and other requirements.

DOD guidance requires that the military services take action on recommendations from reviews, evaluate those actions, and provide information on the status of those actions.[68] Also, *Standards for Internal Control in the Federal Government* calls for management to monitor the status of remediation efforts and evaluate the results, and to complete and document corrective actions to remediate deficiencies on a timely basis.[69] Navy guidance also notes that the capabilities of the LCS with respect to anti-submarine warfare, mine warfare, and surface warfare are severely limited when the seaframe is not integrated with the required mission modules.[70] The LCS *Test* and *Evaluation Master Plan*, which DOD initially approved in 2013 and updated in 2018, requires that DOD conduct a series of developmental, operational, and live-fire tests to demonstrate and evaluate whether the LCS is achieving its mission capabilities.[71] The plan requires testing and evaluation of the seaframes, as well as mission modules, to provide timely and reasonable assessments before they go into full production and to ensure that they can carry out operational and warfighting capabilities.

The Navy has begun to take steps to address some of the issues encountered on LCS deployments. Specifically, based on documentation provided by the Navy, it assesses ships' equipment before they deploy overseas. These assessments are aimed at identifying and mitigating risks with equipment and systems by, among other things, training the crew on operating, maintaining, and troubleshooting key equipment before they deploy. For example, in 2020 the Navy performed a pre-deployment assessment on the USS *Sioux City's* (LCS-11) electrical equipment, including the ship's diesel generators, switchboards, and

[68]DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense (IG DOD) and Internal Audit Reports* (Dec. 18, 2014) (incorporating change 1, Jan. 31, 2019).

[69]GAO-14-704G.

[70]OPNAVINST 3501.352A.

[71]Office of the Secretary of Defense (Operational Test and Evaluation), *Approval of the Littoral Combat Ship (LCS) Test and Evaluation Master Plan (TEMP), Number 1695, Revision B* (Jan. 29, 2018).

power supply. The assessment identified and corrected a number of issues, including replacing dead batteries, cleaning dirt and debris from the power supply, and identifying corrosion on some of the wiring for the engine sensor.

However, the Navy does not have a comprehensive plan, including estimated costs and time frames, for addressing the deficiencies identified from operational testing and evaluation for the seaframes; performing adequate operational testing and evaluation of the mission modules to demonstrate their operational and warfighting capabilities; and fully implementing lessons learned from LCS deployments related to design, navigation, engine propulsion, and other operational issues.[72]

DOT&E officials told us that, as a result, they have been unable to evaluate whether the Navy has remediated the challenges it has identified to the operational effectiveness or suitability of the seaframes. As previously discussed, Navy officials stated that they coordinate with DOT&E to implement recommendations and address deficiencies; however, these officials could not provide documentation to show that these recommendations had been implemented, or that they planned to address these deficiencies. According to DOT&E officials, the LCS program office does not generally respond to the recommendations or deficiencies from its annual reports.

Without such a comprehensive plan, the LCS will remain at risk of being unable to operate offensively or in high-threat environments—as its operating environment guidance requires—thus jeopardizing its ability to operationally deploy. Unless the Navy tests and implements solutions to significant operational challenges, the LCS will likely continue to face significant challenges in detecting, countering, and surviving threats in combat; navigating in the littorals; navigating through confined bodies of water, such as the Panama Canal; avoiding hull damage; docking at some foreign ports; or remaining in port under challenging force protection conditions.

Collectively, the various operational challenges facing the LCS represent significant departures from the desired capabilities the Navy established for the ship. According to the Navy, these challenges hinder the ability of the LCS to operate outside a benign, low-threat environment. Moreover,

[72]See appendix IV for a summary of GAO prior work, including a comparison between the initial and current LCS program quantity, cost, schedule, and performance.

the LCS has demonstrated operational challenges that call into question its ability to transit to theaters of operation.

These gaps between desired and demonstrated capabilities have substantial implications for the Navy's ability to use the LCS as planned. In some instances, it may not be necessary for the LCS to fully demonstrate all of its desired capabilities. However, in other instances, the inability to execute desired capabilities could hinder the ability to execute the desired mission. Until the Navy makes future operational deployments contingent on demonstrated progress in addressing gaps between desired and demonstrated capabilities, the LCS will continue to be dependent in combat and require protection by multi-mission combatants or multiple LCS for mutual support.

Conclusions

The Chief of Naval Operations' suspension of LCS deployments in 2017 gave the Navy an opportunity to ensure that challenges encountered in prior LCS deployments would serve as lessons learned, with a goal of improving the ship's operational availability. The Navy has implemented many recommendations from the 2016 Review to address issues related to crewing and filling positions, training, maintenance, and operations. However, the Navy continues to face challenges in implementing its revised maintenance approach to reduce reliance on contractors. Conducting a study to determine the number of maintenance teams and personnel, a feasible set of tasks to be performed by these teams, how to obtain technical data needed to perform maintenance, and how to use these teams to fill vacancies on the LCS would position the Navy to better address these challenges.

In addition, the Navy has not assessed the potential cost implications of its revised maintenance approach, and its O&S cost estimates for the LCS are outdated and do not reflect the operational and sustainment concepts that the Navy revised in response to the 2016 Review. Further, the Navy is not reporting complete and accurate O&S costs for its mission modules. These limitations in its cost data prevent comparisons between estimated and actual O&S costs for the program. As a result, the Navy is at risk of failing to plan for cost increases that could create funding challenges for the LCS, which jeopardizes the ability to deliver capabilities at the time they are expected. In addition, the lack of complete and accurate O&S cost estimates hinders the ability of DOD and the Navy to provide oversight and make funding decisions about the LCS program.

Most significantly, the Navy continues to face substantial challenges in demonstrating the operational and warfighting capabilities the LCS fleet needs to perform its missions. Many of the problems with the seaframes and mission modules were revealed during developmental and operational testing over the past several years. Further, the LCS has encountered significant problems during its limited number of deployments. However, the Navy does not have a comprehensive plan, including estimated costs and time frames, for addressing the deficiencies identified from DOT&E operational testing and evaluation of the seaframes; performing adequate operational testing of the mission modules; and fully implementing lessons learned from completed deployments.

Collectively, these problems demonstrate gaps between the Navy's desired and its demonstrated capabilities for the LCS. Until the Navy takes further action to address these gaps, the LCS will continue to remain out of synch with desired operational capabilities, such as operating offensively in a high-threat environment.

Recommendations for Executive Action

We are making six recommendations to the Navy:

The Secretary of the Navy should ensure that the Chief of Naval Operations conducts a study to determine the appropriate number of maintenance teams and personnel, a feasible set of tasks to be performed by these teams, how to obtain technical data needed to perform maintenance, and how to use these teams to fill vacancies on the LCS. (Recommendation 1)

The Secretary of the Navy should ensure that the Chief of Naval Operations assesses the implications of the Navy's revised maintenance approach for the LCS seaframes on future O&S costs. (Recommendation 2)

The Secretary of the Navy should ensure that Naval Sea Systems Command updates the cost estimates for the LCS to include operating and support costs, incorporate data from completed LCS deployments, and reflect current and planned revised operational and sustainment concepts. (Recommendation 3)

The Secretary of the Navy should ensure that the Program Executive Office Unmanned and Small Combatants reports complete and accurate operating and support cost data in VAMOSC for LCS mission modules on a per ship and per mission module basis. (Recommendation 4)

The Secretary of the Navy should ensure that the LCS program office, in coordination with the Chief of Naval Operations, develops a comprehensive plan, including estimated costs and time frames, for addressing deficiencies in the seaframes, performing adequate testing of mission modules, and implementing lessons learned from completed deployments. (Recommendation 5)

The Secretary of the Navy should ensure that the Chief of Naval Operations, to the extent practicable, makes future operational deployments contingent on demonstrated progress in addressing gaps between desired and demonstrated capabilities. (Recommendation 6)

Agency Comments and Our Evaluation

We provided a draft of the sensitive report to the Secretary of the Navy for review and comment. The department's comments on the sensitive report are reprinted in appendix VI. The Navy concurred with five of our six recommendations, and partially concurred with our remaining recommendation.

The department stated that it had actions underway, or planned to take actions, to address the five recommendations with which it concurred. Specifically, the department stated:

- Task Force LCS has actions underway to address our recommendations that the Navy study the use of maintenance teams and assess the cost implications of the revised maintenance approach. According to documentation provided by Navy officials, the Task Force LCS, headed by the Commander of Naval Surface Forces, addresses reliability and sustainability issues to help the LCS meet its forward presence requirements. It also aims to improve communication with the government, DOD leadership, and industry leaders to build confidence in the LCS's effectiveness in executing its mission.
- NAVSEA and the LCS Strike Team have actions underway to update LCS operating and support cost estimates. According to Navy officials, the LCS Strike Team is part of the Task Force LCS, headed

by the Program Executive Officer for Unmanned and Small Combatants, is addressing ways to help minimize downtime and maximize mission success for the LCS, focusing on resolving issues related to organic capability and improving access to original equipment manufacturers.

- Task Force LCS and the LCS Strike Team have actions underway to develop a comprehensive plan for addressing deficiencies in the LCS seaframes, to perform adequate testing of mission modules, and to implement lessons learned from completed deployments.
- Task Force LCS will take action to make future operational deployments contingent on demonstrated progress in addressing gaps between desired and demonstrated capabilities.

DOD partially concurred with our recommendation to report complete and accurate O&S cost data for LCS mission modules on a per ship and per mission module basis. The department agreed to expand its submission of O&S cost data for all cost categories on a per mission module basis. However, the department stated that submitting the data on a per ship basis would not provide a comprehensive representation of the operating status, such as capturing all support costs for mission packages not embarked on a ship but undergoing maintenance.

We continue to believe that it is important for DOD to report O&S cost data on a per mission module and per ship basis. Without complete and accurate information on O&S costs on a per ship basis, the Navy will not be able to analyze the differences between estimates and actuals. Such analysis could help identify and mitigate critical cost risks and unexpected cost increases for the LCS. This is particularly important given the program's history of significant cost growth to date. As we reported in March 2020, the LCS had a 60 percent growth in O&S costs from the program's initial per ship annual estimate in 2011 to its current 2020 estimate.[73] This was the highest rate of per ship O&S cost growth we reported among the shipbuilding programs in our O&S cost analysis at that time.

The Secretary of the Navy also provided technical comments, which we incorporated as appropriate.

We are sending copies of this report to the appropriate congressional committees, the Secretary of Defense and the Secretary of the Navy. In

[73]GAO-20-2.

addition, the report is available at no charge on the GAO website at https://www.gao.gov.

If you or your staff have any questions about this report, please contact Diana Maurer at (202) 512-9627 or maurerd@gao.gov. GAO staff who made key contributions to this report are listed in appendix VII.

Diana Maurer
Director, Defense Capabilities and Management

Appendix I: Objectives, Scope, and Methodology

This report examines the extent to which the Navy has (1) implemented the recommendations and addressed the challenges identified in the 2016 Review, (2) updated its Littoral Combat Ship (LCS) cost estimates and included actual cost data to account for the revised operational and sustainment concepts, and (3) demonstrated that the LCS has the operational and warfighting capabilities it needs to perform its missions.[1]

This report is a public version of a sensitive report that we issued in August 2021.[2] We subsequently worked to obtain DOD's review and concurrence on changes necessary for public release. DOD deemed some of the information in our August 2021 report to be sensitive, which must be protected from public disclosure. Therefore, this report omits sensitive detailed information pertaining to performance capabilities, personnel requirements, and sustainment challenges of the LCS. Although the information provided in this report is more limited, the report addresses the same objectives as the sensitive report and uses the same methodology.

To determine the extent to which the Navy has implemented the recommendations and addressed the challenges identified in the 2016 Review report, we reviewed and analyzed the recommendations from the 2016 Review and compared them to the steps that the Navy had taken to implement them. Two GAO analysts independently evaluated the 2016 Review and the steps taken to implement its recommendations in order to determine the extent to which the recommendations were implemented. Each analyst assigned a status of either implemented, in progress, or not implemented to each recommendation. These analysts reviewed documentation on these recommendations and challenges in

[1]In response to the House report, H.R. Rep. No. 116-120, at 92 (2019), we also issued GAO, *Littoral Combat Ship: Unplanned Work on Maintenance Contracts Creates Schedule Risk as Ships Begin Operations*, GAO-21-172 (Washington, D.C.: Apr. 29, 2021).

[2]GAO, *Littoral Combat Ship: Actions Needed to Address Significant Operational Challenges and Implement Planned Sustainment Approach,* GAO-21-331SU (Washington, D.C.: Aug. 5, 2021).

implementing these recommendations, such as program briefings, unit personnel documents, training manuals, and maintenance planning documents. These analysts also assessed the documentary and testimonial evidence we collected against Department of Defense (DOD) and Navy guidance and *Standards for Internal Control in the Federal Government*.[3] Once agreement was reached between the two analysts, a third, independent analyst conducted an additional review to verify the accuracy of the analysis. We determined that the monitoring component of internal control was significant to this objective, along with underlying principles that management should monitor the findings and recommendations from reviews and address findings and recommendations that warrant management action.[4]

To determine the extent to which the Navy updated its LCS cost estimates and included actual cost data to account for the revised operational and sustainment concepts, we reviewed available operating and support (O&S) costs for the seaframes and mission modules from the (1) program life-cycle cost estimates prepared in 2011, 2013, and 2018; (2) Selected Acquisition Report cost estimates from fiscal years 2004 through 2019; (3) Naval Visibility and Management of Operating and Support Costs (VAMOSC) database from fiscal years 2009 through 2019; and (4) cost data from LCS squadrons and program briefings between fiscal years 2017 and 2019. We analyzed available O&S cost data provided by the Navy for LCS from VAMOSC and interviewed officials to identify areas where costs would be likely to rise, at least temporarily, as a result of the revised maintenance approach. We assessed the documentary and testimonial evidence we collected against DOD and Navy guidance and leading practices for cost estimating in GAO's *Cost Estimating and Assessment Guide*.[5]

[3]DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense (IG DOD) and Internal Audit Reports* (Dec. 18, 2014) (incorporating change 1, Jan. 31, 2019); Department of the Navy, COMNAVSURFPAC/COMNAVSURFLANT Instruction 3502.7A (Jan. 9, 2020); and GAO, *Standards for Internal Control in the Federal Government*, GAO-14-704G (Washington, D.C.: September 2014).

[4]GAO-14-704G.

[5]DOD Instruction 5000.73, *Cost Analysis Guidance and Procedures* (Mar. 13, 2020); Secretary of the Navy Instruction (SECNAVINST) 7000.29A *Naval Visibility and Management of Operating and Support Costs Program Data Collection* (Jan. 26, 2021); and GAO, *Cost Estimating and Assessment Guide*, GAO-20-195G (Washington, D.C.: March 12, 2020).

To determine the extent to which the Navy has demonstrated that the LCS has the operational and warfighting capabilities it needs to perform its missions, we reviewed reports from the Director, Operational Test and Evaluation (DOT&E), from 2003 through 2020. We also reviewed post-deployment reports from 2017 through 2020; casualty reports from 2019 and 2020; lessons learned reports from 2013, 2017, and 2018; and other documents regarding the LCS's ability to perform its missions.[6] We assessed the documentary and testimonial evidence we collected against DOD and Navy guidance and standards for internal control.[7] We determined that the monitoring component of internal control was significant to this objective, along with underlying principles that management should monitor the status of remediation efforts and evaluate the results; and complete and document corrective actions to remediate deficiencies on a timely basis.[8] We assessed the status of remediation efforts by the Navy and whether it had completed and documented corrective actions to remediate deficiencies on a timely basis.

To address all three objectives, we reviewed relevant laws, regulations, DOD and Navy guidance, and our prior reports related to the operation and sustainment of the LCS program. We reviewed prior reports related to the history of the LCS program, schedule delays, associated costs, and operational challenges of the LCS. We also analyzed documentation and interviewed knowledgeable officials from Navy and DOD organizations involved in designing, building, sustaining, and operating the LCS to gain an understanding of their roles in LCS operations and sustainment. These interviews also provided information on the nature and magnitude of LCS sustainment issues. For each organization below, we developed detailed questions to inform our discussions and received oral and written responses to our questions from these organizations. The DOD and Navy organizations included in our review are as follows:

[6]A casualty report is an operational report used to document mechanical issues the crew encounters. These reports represent significant deficiencies to the pieces of equipment that contribute to the ship's ability to perform its missions.

[7]Office of the Secretary of Defense (Operational Test and Evaluation), *Approval of the Littoral Combat Ship (LCS) Test and Evaluation Master Plan (TEMP), Number 1695, Revision B* (Jan. 29, 2018); Department of the Navy, Chief of Naval Operations Instruction (OPNAVINST) *3501.352A*; DOD Instruction 7650.03, *Follow-up on Inspector General of the Department of Defense (IG DOD) and Internal Audit Reports* (Dec. 18, 2014) (incorporating change 1, Jan. 31, 2019); and GAO-14-704G.

[8]GAO-14-704G.

Department of Defense

- Office of the Under Secretary of Defense for Acquisition & Sustainment
  - Office of the Deputy Assistant Secretary of Defense for Materiel Readiness
- The Office of Cost Assessment and Program Evaluation
  - Data Collection and Cost Estimates
- Director for Operational Test and Evaluation
  - Naval Warfare

Department of the Navy

- United States Fleet Forces Command
  - Commander, Naval Surface Force, U.S. Pacific Fleet
  - Commander, Naval Surface Force, U.S. Atlantic Fleet
- Deputy Assistant Secretary of the Navy – Ships
- Chief of Naval Operations
  - Fleet Readiness (N83)
  - Surface Warfare Division (N96)
- Naval Center for Cost Analysis
- Naval Supply Systems Command
  - N4 (Supply Chain Management Policy & Performance)
  - N5 (Operations and Warfare Engagement)
  - N7 (Contracting)
  - Weapon Systems Support
- Naval Sea Systems Command
  - 05 (Naval Systems Engineering Directorate)
- LCS Program Executive Office
  - Program Manager-Ships 420 LCS Mission Modules
  - Program Manager-Ships 501 Littoral Combat Ships
  - Program Manager-Ships 505 LCS Fleet Introduction & Sustainment

- LCS Class squadrons in Mayport, Florida, and San Diego, California
- Mission Package Support Facility
- Southeast Regional Maintenance Center, Mayport, Florida
- Southwest Regional Maintenance Center, San Diego, California
- Bahrain and Singapore Forward Deployed Regional Maintenance Centers

To assess the reliability of the data sources we used to conduct our analyses, we developed specific questions regarding the cost data, interviewed Navy officials, and reviewed documentation that they provided on the seaframes and mission modules, such as an overview of the VAMOSC database and its user manual. We reviewed additional documentation the Navy provided in response to our questions regarding the cost data for the LCS. Navy officials provided information that included an overview of the data sources, how the information was collected, definitions of variables, data quality controls, and perceptions of overall data quality. We also performed electronic data testing for missing data, outliers, and obvious errors. We interviewed Navy officials to obtain clarification and discussed our plans for how we intended to use the data. Additionally, we shared the data with the program offices that manage the LCS for review and comment. We determined that the data are reliable for the purpose of reporting on O&S costs for the seaframes and the minimum maintenance costs for the mission modules, but are not reliable for reporting on overall O&S costs as discussed in this report.

As a result of limitations on government operations in response to the novel coronavirus (COVID-19), we were not able to physically observe specific activities performed to operate and sustain the LCS, or to conduct site visits to their homeports, regional maintenance centers, or support facilities.

We conducted this performance audit from November 2019 to August 2021 in accordance with generally accepted government auditing standards. Those standards require that we plan and perform the audit to obtain sufficient, appropriate evidence to provide a reasonable basis for our findings and conclusions based on our audit objectives. We believe that the evidence obtained provides a reasonable basis for our findings and conclusions based on our audit objectives.

We subsequently worked from August 2021 to February 2022 to prepare this version for public release. This public version was also prepared in accordance with those standards.

Appendix II: Overview of Littoral Combat Ship (LCS) Program

The Navy's design for the LCS was to support specific surface, submarine, and mine countermeasures missions to achieve operational and warfighting capabilities (see fig. 11). These missions contain modules and are divided into the following:

- **Anti-submarine warfare (ASW) mission** has two modules: escort mission module and aviation mission module,
- **Mine countermeasures (MCM) mission** has six modules: airborne mine neutralization module, near surface detection module, coastal mine reconnaissance module, unmanned mine sweeping module, buried minehunting module, and remote minehunting module, and
- **Surface warfare (SUW) mission** has four modules: gun mission module, maritime security mission module, surface to surface mission module, and aviation mission module.

The LCS has some features that other Navy surface ships do not. For example, the flight deck on the *Freedom* variant is larger than those on Navy guided missile frigates, destroyers, and cruisers. The flight deck on the *Independence* variant is the largest of any current surface combatant; its hangar bay is able to hold two MH-60 helicopters. The Navy had planned to select one variant of the seaframe.[1] However, in December 2010 it awarded contracts to build both variants.

[1]On February 27, 2015, the Navy issued its Small Surface Combatant Task Force Report, which evaluated alternative approaches for the Navy to procure a capable and lethal surface combatant generally consistent with the capabilities of a frigate. Department of the Navy, *Small Surface Combatant Task Force (SSCTF) Report* (Feb. 27, 2015).

Figure 9: Overview of the Littoral Combat Ship

Mission	Defeat asymmetric anti-access threats such as mines, quiet diesel submarines, and fast surface craft	
Capabilities	57MM gun, SeaRAM missiles, .50-Cal machine guns, the ALEX Decoy System, and mission packages	
Crew	70	
Propulsion	Two steerable and two fixed-boost waterjets driven by a combined diesel and gas turbine main propulsion system	Two steerable waterjets driven by diesel engines and two steerable waterjets driven by gas turbine engines
Design	Steel and aluminum mono-hull ship	Aluminum trimaran ship
Length	387 feet	418 feet
Weight	3,090 metric tons	3,100 metric tons
Manufacturer	Lockheed Martin - Marinette Marine in Marinette, Wisconsin	General Dynamics - Austal USA in Mobile, Alabama
Homeport	Mayport, Florida (Squadron Two)	San Diego, California (Squadron One)

Mission packages

Surface warfare

Provides maritime security and destruction of small boat threats

Mine countermeasures

Detects and neutralizes mine threats

Anti-submarine warfare

Detects, classifies, localizes, and destroys enemy submarines in shallow waters

Aviation detachment	Each seaframe is also assigned an aviation detachment with an additional crew of 19 to 23 persons to operate and maintain manned and unmmaned helicopters.

Source: GAO analysis of prior GAO reports and Navy documentation; Photos (clockwise from top left): U.S. Navy/Petty Officer 2nd Class James Evans, U.S.Navy/Chief Petty Officer Shannon Renfroe, U.S. Navy/Petty Officer 2nd Class Anderson W. Branch, U.S. Navy/Petty Officer 1st Class Brian Brooks, and U.S. Navy/Petty Officer 2nd Class Kaleb Staples. | GAO-22-105387

Note: Some details on seaframe capabilities were omitted because this information is sensitive.

Appendix III: Littoral Combat Ship (LCS) 2016 Review Team Report Long-Term Actions

In addition to the 10 short-term recommendations, the Navy included 33 longer-term actions in its 2016 Review (see table 5). The Navy stated that these near- and long-term actions will require further study beyond the 60-day review. For example, the review team identified a need to fill a supply officer position to address the complexities of logistics tasks on each ship (see action #25 below). Navy officials told us they are determining whether this position is needed.

Table 5: Longer-Term Actions Proposed by the Littoral Combat Ship (LCS) 2016 Review Report

Action Number	Action
1	LCS Command and Control at Program Maturity The LCS command and control framework should be reviewed to ensure that it addresses the new division-based Blue/Gold-Plus crewing concept with the number of ships and crews assigned to each LCS squadron when the program reaches maturity.
2	Implementation of Testing and Training Ship Concepts Develop a plan of action to phase in testing and training ships that focuses on personnel requirements, certification, maintenance, and integrated scheduling.
3	Developing a Holistic Approach to LCS Testing Requirements Conduct a full review of certification and testing requirements to determine if these requirements can be met with a more holistic approach that decreases their impact on the LCS fleet's operations.
4	Institutionalizing the Maintenance Execution Teams Assess the potential benefits and costs associated with the maintenance execution team concept and formalize the personnel and utilization process.
5	Training to Integrate LCS into Broader Force Study the integrated training ships to determine the most efficient manner in which to prepare LCS ships and crews for deployment, as well as arming fleet commanders and others with the knowledge and experience to properly use LCS as part of a large force.
6	Condition-Based Maintenance Resourcing and Implementation Analyze the feasibility and affordability of "low tech" options, such as manual data gathering and analysis to support better trend analysis.
7	Creating a Viable Sea/Shore Career Continuum for LCS Sailors Examine the structure of LCS shore positions and sea/shore continuum policy specific to LCS to build LCS-specific skills.

Action Number	Action
8	Review of LCS Warfighting Tactics Following Fiscal Year 2018 Deployment Assess LCS warfighting and tactics following LCS deployments in 2018 to capture early lessons.
9	Global LCS Expeditionary Maintenance and Logistics Requirements Conduct a study that determines the appropriate amount of government-provided expeditionary maintenance and repair teams and facilities necessary to fulfill requirements.
10	Module Allocation Following Frigate Introduction Conduct an analysis that includes both LCS and frigates to inform decisions on procurement and how these ships will be used to meet mission requirements.
11	Mine Countermeasures Mission Package Employment on Platforms Other Than LCS Expand the delivery of mine countermeasures capability beyond LCS to other platforms.
12	Integration of Surface Warfare Mission Package Elements into Other Mission Packages Permanently incorporate elements of the surface warfare mission package into the capability of all seaframes and crews. Further analyze and assess elements of the surface warfare mission package to account for space, weight, power, maintenance, and personnel requirements to support an increased capability without compromising the capacity of mission packages.
13	Assess Long-Term Requirements of Maintenance Teams Conduct a study regarding the maintenance team concept to determine the correct balance of ratings and pay grades, including the development of mission, functions, and tasks of the maintenance execution teams and reserve duty support for maintenance execution teams, the role of apprentice sailors, and utilization of maintenance execution teams in forward operating sites.
14	Increase LCS Squadron Fill Priority Until the crewing recommendations from the 2016 review have been implemented, there should be a 95 percent crew fill rate. The 2016 Review recommends a target crew fill rate of 90 percent once these recommendations have been fully implemented.
15	Examine LCS Sea/Shore Continuum for Enlisted Sailors Conduct a more extensive study to identify and fund LCS-specific positions to build expertise within the program at supporting shore organizations, such as the regional maintenance centers, the afloat training group, Navy Education and Training Command, and the LCS squadrons. Examine sequencing sea and shore rotations, including potential adjustments of sea tour lengths, to accommodate the Blue and Gold crew rotations, and explore policy proposals regarding whether the LCS program should include special duty incentive pay and advancement pay.
16	Establish Maintenance Teams Formalize and codify the billet structure and missions, functions, and tasks of the LCS squadron maintenance teams.
17	Establish a Field Calibration Activity at the LCS Squadron Have field calibration performed by the maintenance execution team, to decrease LCS reliance on contracted maintenance providers and allow for greater flexibility in meeting the ship’s operational schedule.

Action Number	Action
18	Discontinue Civilian On-Board Rider Program for Freedom Variant According to the Navy, although the on-board rider program enhances the ship's ability to perform repairs, the presence of a civilian rider is not required in the LCS Concept of Operations. Also, reliance on contractors to perform repairs negatively affects the crew's development of technical proficiency and compromises their sense of ownership.
19	Improve Regional Maintenance Center Capability and Capacity Fully implement and support fleet technical assistance and material assessment events on LCS, serving to improve material readiness and utilization of government resources.
20	Increase Regional Maintenance Center Capability to Work on LCS Critical Systems That Currently Require Original Equipment Manufacturers Service Reduce LCS's reliance on contractors and shift this maintenance workload to the regional maintenance centers.
21	Fully Implement Reliability Engineering Condition-Based Maintenance Install full reliability engineering and condition-based maintenance sensors and instrumentation on ships that do not have them or where they have only been partially installed and ensure that new construction ships are built with reliability engineering and condition-based maintenance sensors and instrumentation.
22	Validate the 32-Month Docking Requirement and Solidify the Future-Docking Plan Review the 32-month LCS dry-docking requirement to determine whether it is necessary to address dry dock capacity issues.
23	Formalize and Fund LCS Modernization The LCS program office should prioritize specific maintenance requirements, such as safety, system and parts obsolescence, and reliability, to ensure the longevity of the ship class.
24	Provide Commander, Destroyer Squadron (CDS) 7 with Additional Capability to Support LCS and Lessen Reliance on LCS Squadron (LCSRON) ONE Destroyer Squadron 7 should possess a more robust LCS support of its own.
25	LCS Supply Officer Position Update the Ship's Manning Requirements document to make the necessary changes to the Navy Personnel Command, Commander, Naval Surface Forces Pacific N41, and LCS squadron, to fill the billet with a Supply Officer.
26	Advance Operational Capability of Anti-Submarine Warfare and Mine Countermeasures Mission modules within both the anti-submarine and mine countermeasures missions should continue to advance to operational capability to inform iterative improvements to the LCS Warfighting Concept of Operations document and priority investments in future and expanded capabilities.
27	Sustaining Mine Countermeasures Capability According to the Navy, the mission modules within the mine countermeasures mission will sustain the Navy's legacy mine countermeasures capability and has the potential to provide a more robust and less costly mine hunting capability to the fleet.

Action Number	Action
28	Operational Experimentation and Analysis Conduct operational experimentation and analysis, such as a dual deployment with LCS and the MH-60R helicopter, to perform electronic maneuvering warfare and special warfare operations to improve tactics, techniques, and procedures for LCS employment.
29	Expanding Modularity Expand modularity of the mine countermeasures mission package beyond the LCS to other surface ships.
30	Baseline Combat Capability Incorporate elements of the surface warfare mission package in all LCS as a baseline combat capability.
31	Maintain LCS Modularity Maintain the modularity of the LCS by sustaining and exercising the ability to exchange mission-specialized LCS crews.
32	Command and Control To simplify program reporting, scheduling, and oversight, and to de-conflict testing requirements with LCS deployment schedules, all external requirements and inquiries, to include initial operational test & evaluation (IOT&E), should occur first at Echelon III.
33	Incentives for LCS Sailors Conduct a cost benefit analysis to evaluate incentives, such as pay, career options, and opportunities, to entice experienced sailors to return to the LCS community.

Source: Navy documentation. | GAO-22-105387

Appendix IV: Summary of GAO Prior Work

Since the program began, we have reported that the LCS has been experiencing cost overruns, schedule delays, and performance issues. Table 6 compares the initial LCS program to the current LCS program in terms of quantity and costs, schedule, and performance.

In July 2007 we reported that costs for the first two seaframes had more than doubled from the original cost estimates.[1] In February 2010 we reported that the Navy's O&S costs for LCS could total $84 billion (in constant fiscal year 2009 dollars) through about 2050.[2] The Navy implemented three of the eight recommendations we made in that report—to update its cost estimates—but did not implement the other recommendations, such as using the updated estimate to analyze the costs and benefits of the two seaframe variants being built and assessing the long-term affordability of the LCS program.

In July 2014 we reported that the annual per ship costs for LCS were nearing or might exceed those of other surface ships, including larger ships and ships with larger crews.[3] In that report we emphasized our prior recommendations that, before buying more LCS ships, the Navy should collect additional data and update its cost estimates. In March 2020 we reported that current LCS O&S cost estimates were significantly higher than the initial estimates, because the Navy did not account for sustainment risks in its initial estimates.[4]

[1]GAO, *Defense Acquisition: Realistic Business Cases Needed to Execute Navy Shipbuilding Programs,* GAO-07-943T (Washington, D.C.: July 24, 2007).

[2]GAO, *Littoral Combat Ship: Actions Needed to Improve Operating Cost Estimates and Mitigate Risks in Implementing New Concepts,* GAO-10-257 (Washington, D.C.: Feb. 2, 2010).

[3]GAO, *Littoral Combat Ship: Deployment of USS Freedom Revealed Risks in Implementing Operational Concepts and Uncertain Costs,* GAO-14-447 (Washington, D.C.: July 8, 2014).

[4]GAO, *Navy Shipbuilding: Increasing Focus on Sustainment Early in the Acquisition Process Could Save Billions*, GAO-20-2 (Washington, D.C.: Mar. 24, 2020).

Table 6: GAO Comparison between Initial and Current Littoral Combat Ship (LCS) Programs, as of February 2021

n/a	Initial LCS program	Current LCS program
Quantity and cost	• 55 seaframes • $220 million per seaframe • 64 mission packages, $2.3 billion total cost • (approximately $36 million per package) • Originally planned at 40 sailors in 2005, then increased to 50 in 2013 operating the seaframe; and 15-20 sailors operating the mission modules separately and operating under separate commands	• 35 seaframes • $478 million per seaframe • 44 mission packages, $5.8 billion (approximately $138 million per package) • Merge crew for seaframe and mission modules for a combined crew of about 70 sailors operating under one command
Schedule	• Initial operational capability for the seaframes was expected in 2007, 3 years after program initiation • Initial operational capability was expected for all mission modules by 2010	• Initial operational capability with partial capability for *Freedom* variant in 2014 and *Independence* variant in 2015—10 and 11 years, respectively, after program initiation • Initial operational capability achieved for four mission modules by 2019, and planned initial operational capability for the remaining mission modules by 2022

Source: GAO analysis of prior GAO reports and Navy documentation. | GAO-22-105387

We also reported on LCS schedule delays: for example, the delay in achieving initial operational capability. Although initial operational capability for both seaframe variants was planned for 2007, the *Freedom* variant did not achieve initial operational capability until 2014, and the *Independence* variant until 2015. We testified in 2016 that the mission modules were also behind schedule.[5] The Navy was expecting to reach initial operational capability for all 12 mission modules by 2010, but only partial capability had been reached in 2014 for three of the four mission modules within the surface warfare mission: gun mission module, maritime security mission module, and the aviation mission module.[6] The fourth mission module within the surface warfare mission—surface to surface mission module—reached initial operational capability in 2019. In this same testimony, we found that deliveries of almost all seaframes under contract (LCS-5 through LCS-26) had been delayed by several

[5]GAO, *Littoral Combat Ship and Frigate: Slowing Planned Frigate Acquisition Would Enable Better-Informed Decisions,* GAO-17-279T (Washington, D.C.: Dec. 8, 2016).

[6]Initial operational capability is a key milestone in weapon system acquisitions that typically refers to the point in time when the warfighter (in the Navy's case, the operational fleet) has the ability to employ and maintain a new system. Full operational capability refers to the point when a weapon system is delivered to the warfighter (in the Navy's case, the operational fleet) and the warfighter has the ability to fully employ and maintain it to meet an operational need.

months—in some cases by a year or longer.[7] The Navy originally expected to have all 55 ships in the class delivered by fiscal year 2018, but that expectation was reduced to delivering 17 ships by fiscal year 2019.

We have also reported on the Navy's inability to demonstrate that the LCS could meet the minimum level of capability that was required at the beginning of the program. In July 2017 the Navy accepted delivery of the USS *Fort Worth* (LCS-3) and the USS *Coronado* (LCS-4) with numerous quality problems that persisted after these ships were delivered to the fleet.[8]

In June 2018 we reported on quality problems with those two lead ships, the USS *Freedom* (LCS-1) and the USS *Independence* (LCS-2). Specifically, we reported that the Navy accepted these two ships—which had many deficiencies and were of poor quality—and that the ships did not pass operational testing. However, the Navy continued with the acquisition of subsequent ships.[9]

In July 2014 we reported that the Navy had not yet addressed existing risks in executing key concepts such as filling positions, training, and maintenance.[10] In December 2015 we reported that the lethality and survivability of the ships were unproven, and that although the Navy was moving forward with the purchase of additional ships, it did not have plans to address these issues.[11] We recommended to Congress that it delay funding for fiscal year 2016 until the Navy submitted a completed rough-water trials report, an acquisition strategy, and a plan to update and make modifications to the program—and that Congress consider not fully

[7]GAO-17-279T.

[8]GAO, *Navy Shipbuilding: Policy Changes Needed to Improve the Post-Delivery Process and Ship Quality,* GAO-17-418 (Washington, D.C.: July 13, 2017).

[9]GAO, *Navy Shipbuilding: Past Performance Provides Valuable Lessons for Future Investments*, GAO-18-238SP (Washington, D.C.: June 6, 2018).

[10]GAO-14-447. We also previously reported that the Navy often validated sustainment assumptions contained in sustainment planning documents without evaluating those assumptions and identifying key areas of risk, even when programs introduced new sustainment concepts. See GAO-20-2.

[11]GAO, *Littoral Combat Ship: Knowledge of Survivability and Lethality Capabilities Needed Prior to Making Major Funding Decisions,* GAO-16-201 (Washington, D.C.: Dec. 18, 2015).

funding some or all LCS procurement, pending analysis of these documents and the final survivability assessments. The Navy concurred with some of our recommendations and implemented a number of changes, such as reducing the number of total LCS it planned to procure.

As part of our reporting on the cost, schedule, and performance of the LCS, we have made 65 recommendations to improve the LCS program since 2001 (see table 7). DOD has implemented just over half (55 percent) of these recommendations, including four priority recommendations.[12] DOD has not addressed 15 of the recommendations, including two priority recommendations. Another 14 recommendations, including one priority recommendation, remain open.[13]

Table 7: Status of GAO Recommendations for the Littoral Combat Ship Program

n/a	Implemented	Not implemented	Open	Total
Recommendations	32	13	13	**58**
Priority recommendations	4	2	1	**7**
Total	**36**	**15**	**14**	**65**

Source: GAO analysis of prior GAO reports and DOD documentation. | GAO-22-105387

[12]Priority recommendations are those that we believe warrant priority attention from heads of key departments or agencies. They are highlighted because, upon implementation, they may significantly improve government operation—for example, by realizing large dollar savings; eliminating mismanagement, fraud, and abuse; or making progress toward addressing a high-risk or duplication issue.

[13]We consider both implemented and non-implemented recommendations to be closed, as the agency does not plan to take further action on these items. Open recommendations are those that have not yet been addressed by DOD.

Appendix V: Operating and Support Costs for the Littoral Combat Ship (LCS) Program

The Navy prepares O&S cost estimates in its program life-cycle cost estimates and Selected Acquisition Reports for the LCS. The Navy reports O&S cost through its Visibility and Management of Operating and Support Costs (VAMOSC) database for the LCS.

The *Operating and Support Cost-Estimating Guide* categorizes O&S costs into the following six elements:[1]

- **unit level personnel**—cost of operators, maintainers, and other support staff assigned to operating units;
- **unit operations**—cost of unit operating material such as fuel and training material, unit support services, and unit travel;
- **maintenance**—cost of system maintenance, including depot- and intermediate-level maintenance;
- **sustaining support**—cost of system support activities that are provided by organizations other than the system's operating units;
- **continuing system improvements**—cost of system hardware and software modifications; and
- **indirect support**—cost of installation and personnel support that cannot be identified directly to the units and personnel operating a system but can be logically attributed to the system and its associated manpower.

Program Life-Cycle Cost Estimates

The Navy prepared program life-cycle cost estimates for the seaframes and mission modules programs (see table 8). Specifically, the Navy prepared O&S cost estimates for the seaframes program in 2011 and

[1]These six elements are further divided into subcategories. For example, the Navy's maintenance cost element is divided into five subcategories, including consumables, depot-level reparables, depot maintenance, intermediate maintenance, and other maintenance.

O&S cost estimates for the mission modules program in 2013 and 2018. The Navy included the number of seaframes and mission packages in these cost estimates.

Table 8: Operating and Support (O&S) Cost Estimates for the Littoral Combat Ship, from Program Life-Cycle Cost Estimates
Dollars in millions per ship per year (adjusted to fiscal year 2019 dollars[a]

O&S cost elements	Seaframes Program 2011	Mission Modules Program 2013	Mission Modules Program 2018
Unit-level personnel[b]	8.6	3.7	3.7
Unit operations	9.5	0.3	0.2
Maintenance	7.1	3.0	4.0
Sustaining support	6.1	0.6	1.1
Continuing system improvements	8.5	2.0	2.2
Indirect support	3.0	1.0	2.2
Total per seaframe/per mission package per year[c]	**42.9**	**10.6**	**13.5**
Planned number of seaframes/mission packages	55	64	44
Planned service life (in years)	25	30	25

Source: GAO analysis of Navy data. | GAO-22-105387

[a]We adjusted constant year 2010 dollars to fiscal year 2019 dollars using the fiscal year Gross Domestic Product Index.

[b]The Navy refers to this cost element as unit-level manpower.

[c]The mission modules program uses mission packages as the unit of measure for cost and quantity.

Selected Acquisition Reports

The Navy prepares a comprehensive and subsequent follow-up quarterly reports—known as Selected Acquisition Reports—annually for Congress.[2] The National Defense Authorization Act for Fiscal Year 2018 terminated the Selected Acquisition Reports requirement, effective December 31, 2021.[3] The National Defense Authorization Act for Fiscal Year 2020 directed the Secretary of Defense to submit a proposal for an alternative methodology for reporting on all acquisition programs.[4] DOD submitted a proposal in November 2020, but as of March 2021, DOD officials had not provided information on a replacement product.

[2]Selected Acquisition Reports are currently statutorily required quarterly comprehensive reports submitted to Congress including cost, schedule, and performance updates, as compared with the acquisition baseline on major defense acquisition programs. 10 U.S.C. § 2432.

[3]Pub. L. No. 115-91, § 1051 (2017).

[4]Pub. L. No. 116-92, § 830 (2019).

The Navy prepared Selected Acquisition Reports for the seaframes from 2004 through 2019, but O&S cost estimates were not included as part of these reports until fiscal year 2010 (see table 9).

Table 9: Seaframe Operating and Support (O&S) Cost Estimates, from Selected Acquisition Reports

Dollars in millions (base year 2010 dollars)

O&S cost elements	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Unit-level personnel[a]	7.4	7.4	7.4	10.0	8.9	10.8	10.6	10.6	10.9	10.9
Unit operations	8.1	8.1	8.1	7.9	8.7	10.0	10.1	10.1	9.8	9.6
Maintenance	6.1	6.1	6.1	7.6	16.2	17.8	18.1	18.1	18.0	18.5
Sustaining support	5.2	5.2	5.2	6.3	6.0	5.1	4.2	4.2	4.1	4.2
Continuing system improvements	7.2	7.2	7.2	7.7	5.7	6.5	10.4	10.4	10.5	11.0
Indirect support	2.6	2.6	2.6	4.4	4.3	5.2	5.2	5.2	5.3	5.3
Total per seaframe per year	**36.6**	**36.6**	**36.6**	**43.9**	**49.7**	**55.3**	**58.4**	**58.4**	**58.5**	**59.4**
Number of seaframes	55	55	55	32	32	40[b]	32	32	35	35
Service life	25	25	25	25	25	25	25	25	25	25

Source: GAO analysis of Navy data. | GAO-22-105387

[a]The Navy refers to this cost element as unit-level manpower.

[b]Number of seaframes includes frigate and LCS.

The Navy also prepared Selected Acquisition Reports for the mission modules program from 2013 to 2019 (see table 10).

Table 10: Mission Modules Program Operating and Support (O&S) Cost Estimates, from Selected Acquisition Reports

Dollars in millions (base year 2010 dollars)

O&S cost elements	2013	2014	2015	2016	2017	2018	2019
Unit-level personnel[a]	3.2	3.2	3.2	3.2	3.4	3.1	3.1
Unit operations	0.3	0.3	0.3	0.3	0.3	0.2	0.2
Maintenance	2.7	2.7	2.7	2.7	3.4	4.0	4.0
Sustaining support	0.5	0.5	0.5	0.5	0.7	1.0	1.0
Continuing system improvements	3.7	3.7	3.7	3.7	3.7	5.0	5.0
Indirect support	0.9	0.9	0.9	0.9	1.0	1.9	1.9
Total per mission package/per year[b]	**11.2**	**11.2**	**11.2**	**11.2**	**12.4**	**15.2**	**15.2**
Number of mission packages	64	64	64	64	44	44	44
Service life	30	30	30	30	25	25	25

Source: GAO analysis of Navy data. | GAO-22-105387

[a]The Navy refers to this cost element as unit-level manpower.

[b]The mission modules program uses mission packages as the unit of measure for cost and quantity.

Operating and Support Cost Data from the Naval Visibility and Management of Operating and Support Costs (VAMOSC) Database

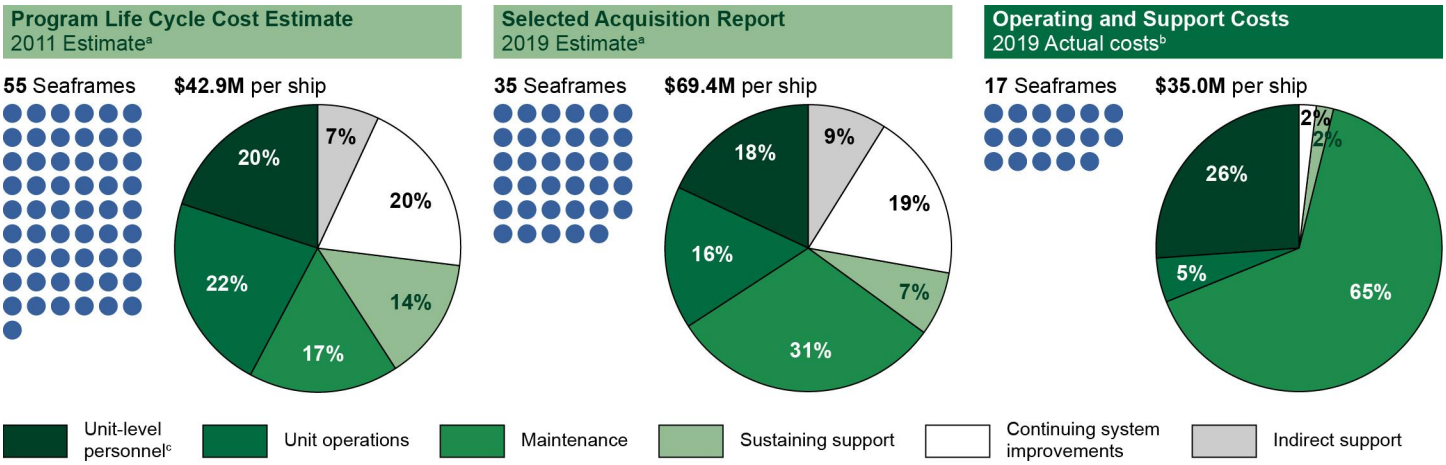
The Navy reports O&S costs for the LCS in its VAMOSC database. The Navy started reporting O&S costs for the seaframes in fiscal year 2009 and has done so every year since. The Navy started reporting maintenance costs for the mission modules program in fiscal year 2015.

Summary of Reported Operating and Support (O&S) Cost Estimates and Actuals

Figure 10 provides a side-by-side summary of reported O&S cost estimates and actuals for the seaframes. The first pie chart shows the 2011 program life-cycle cost estimate, the second shows the 2019 Selected Acquisition Report, and the third shows the 2019 O&S costs incurred from the Navy's VAMOSC database. GAO's *Cost Estimating Guide* states that comparing cost estimates to actuals is an element of cost estimating best practices, and that accurate estimates should examine any variances between estimated and actual costs.[5] However, Navy officials told us that such a comparison would be challenging because of the numerous programmatic changes. They also said that the LCS program is more stable now. Thus, once actual data are complete and accurate and the estimates are revised, these comparisons should be possible.

[5]GAO, *Cost Estimating and Assessment Guide*, GAO-20-195G (Washington, D.C.: Mar. 12, 2020).

Figure 10: Summary of Operating and Support (O&S) Cost Estimates and Actuals for the Seaframes



Source: GAO analysis of Navy data. | GAO-22-105387

Accessible Data for Figure 10: Summary of Operating and Support (O&S) Cost Estimates and Actuals for the Seaframes

n/a	Seaframes	Cost	Unit-level personnel	Unit operations	Maintenance	Sustaining support	Continuing system improvements	Indirect support
Program Life Cycle Cost Estimate 2011 Estimate	55	$42.9M per ship	20%	22%	17%	14%	20%	7%
Selected Acquisition Report 2019 Estimate	35	$69.4M per ship	18%	16%	31%	7%	19%	9%
Operating and Support Costs 2019 Actual costs	17	$35.0M per ship	26%	5%	65%	2%	2%	0

Note: These data are summarized to demonstrate the O&S estimates and actuals over time. It is not a comparison between specific estimates and actual costs because operational and sustainment concepts, such the rotational crewing concept and the revised maintenance, have been implemented or are in progress since these estimates were prepared.

[a]We adjusted constant year 2010 dollars for the program life-cycle cost estimate and base year 2010 dollars for the Selected Acquisition Report to fiscal year 2019 dollars using the fiscal year Gross Domestic Product Index.

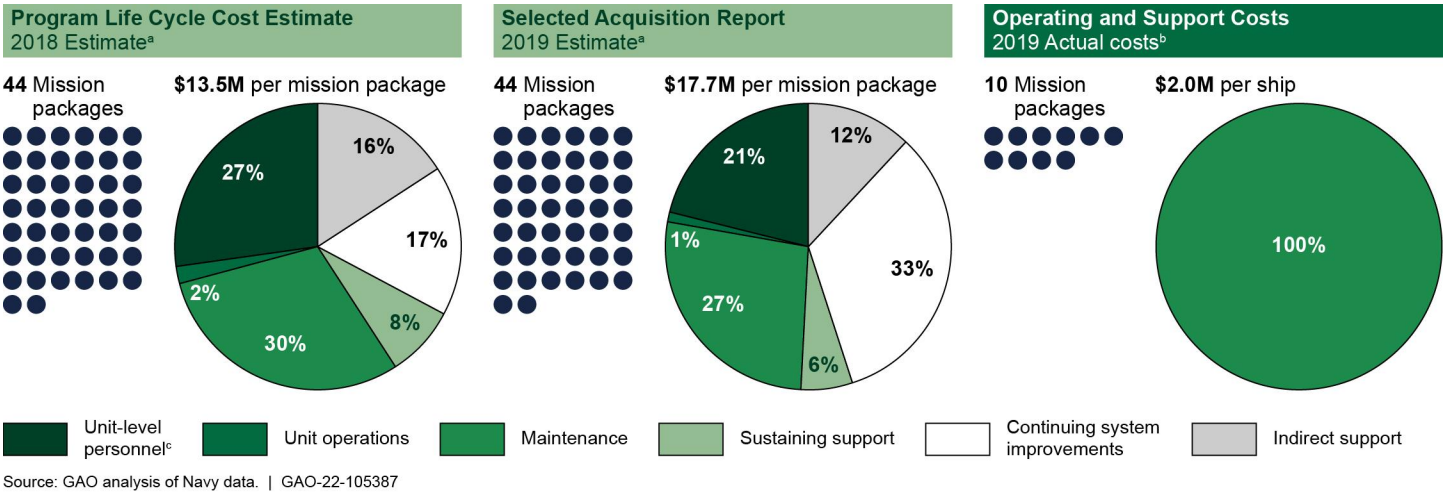
[b]2019 actual costs are from the Naval Visibility and Management Operating and Support Cost database. Also, since indirect support costs are not included in actual costs, the relative percentage is different from the percentage for the estimates.

[c]The Navy refers to this cost element as unit-level manpower.

Figure 11 provides a side-by-side summary of reported O&S cost estimates and actuals for the mission modules program. The first pie

chart shows the 2018 program life-cycle cost estimate; the second shows the 2019 Selected Acquisition Report; and the third shows the 2019 O&S costs incurred from the Navy's VAMOSC cost database.

Figure 11: Summary of Operating and Support (O&S) Costs for the Mission Modules Program



Source: GAO analysis of Navy data. | GAO-22-105387

Accessible Data for Figure 11: Summary of Operating and Support (O&S) Costs for the Mission Modules Program

n/a	Mission packages	Cost	Unit-level personnel	Unit operations	Maintenance	Sustaining support	Continuing system improvements	Indirect support
Program Life Cycle Cost Estimate 2018 Estimate	44	$13.5M per mission package	27%	2%	30%	8%	17%	16%
Selected Acquisition Report 2019 Estimate	44	$17.7M per mission package	21%	1%	27%	6%	33%	12%
Operating and Support Costs 2019 Actual costs	10	$2.0M per ship	0	0	100%	0	0	0

Note: These data are summarized to demonstrate the O&S estimates and actual costs over time. It is not a comparison between specific estimates and actual costs, as the Navy is not reporting complete and accurate O&S costs for the mission modules program. The mission modules program uses mission packages as the unit of measure for cost and quantity.

[a]We adjusted constant year 2010 dollars for the program life-cycle cost estimate and base year 2010 dollars for the Selected Acquisition Report to fiscal year 2019 dollars using the fiscal year Gross Domestic Product Index.

[b]2019 actual costs are from the Naval Visibility and Management Operating and Support Cost database. The Navy reported only maintenance costs for the mission modules program.

[c]The Navy refers to this cost element as unit-level manpower.

Appendix VI: Comments from Department of Defense

THE ASSISTANT SECRETARY OF THE NAVY
Research, Development and Acquisition
1000 Navy Pentagon
Washington DC 20350-1000

JUL 12 2021

Ms. Diana Maurer
Director, Defense Capabilities Management
U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

Dear Ms. Maurer:

Attached are the Department of Defense (DoD) technical comments and responses to the recommendations in GAO Draft Report GAO-21-33SU "LITTORAL COMBAT SHIP: Actions Needed to Address Significant Operational Challenges and Implement Planned Sustainment Approach" (GAO Code 103908).

Sincerely,

Frederick J. Stefany
Acting

Attachments:
As Stated

GAO DRAFT REPORT DATED MAY 6, 2021
GAO-21-331SU (GAO CODE 103908)

"LITTORAL COMBAT SHIPS: ACTIONS NEEDED TO ADDRESS SIGNIFICANT OPERATIONAL CHALLENGES AND IMPLEMENT PLANNED SUSTAINMENT APPROACH"

DEPARTMENT OF DEFENSE COMMENTS
TO THE GAO RECOMMENDATION

RECOMMENDATION 1: The Secretary of the Navy should ensure that the Chief of Naval Operations conduct a study to determine the number of maintenance teams and personnel, feasible set of tasks to be performed by these teams, how to obtain technical data needed to perform maintenance, and how to use these teams to fill vacancies on the LCS.

DoD RESPONSE: Concur. Efforts to address these concerns are already underway by Task Force LCS, under *Line of Operation Two: Sustainability*.

RECOMMENDATION 2: The Secretary of the Navy should ensure that the Chief of Naval Operations assess the implications of the Navy's revised maintenance approach for the LCS seaframes on future O&S costs.

DoD RESPONSE: Concur. Efforts to address these concerns are already underway by Task Force LCS, under *Line of Operation Two: Sustainability*.

RECOMMENDATION 3: The Secretary of the Navy should ensure that Naval Sea Systems Command update the cost estimates for the LCS to include operating and support costs, incorporate data from completed LCS deployments, and reflect current and planned revised operational and sustainment concepts.

DoD RESPONSE: Concur. Efforts underway by NAVSEA and LCS Strike Team.

RECOMMENDATION 4: The Secretary of the Navy should ensure that the Program Executive Office Unmanned and Small Combatants report complete and accurate operating and support cost data in VAMOSC for LCS mission modules on a per ship and per-mission module.

DoD RESPONSE: Partially concur. PEO USC submits maintenance cost on a per Mission Package based on the Operation and Sustainment (O&S) costs for the systems that comprise the Mission Package, and agrees to continue submitting this data while expanding the submittal to cover all O&S cost categories per mission package type (ASW, SUW, MCM). PEO USC does not concur with submitting the data on a per ship basis, because this reporting which is presently captured in VAMOSC, does not provide a comprehensive representation of the operating status. It does not properly capture all support cost to include those Mission Packages not embarked on a ship but undergoing maintenance and Ready For Issue Sustainment support.

RECOMMENDATION 5: The Secretary of the Navy should ensure that the LCS program office, in coordination with the Chief of Naval Operations, develop a comprehensive plan, including estimated costs and timeframes, for addressing deficiencies in the seaframes, performing adequate testing of mission modules, and implementing lessons learned from completed deployments.

DoD RESPONSE: Concur. Efforts already underway by Task Force LCS, *Line of Operation One: Reliability* and the LCS Strike Team.

RECOMMENDATION 6: The Secretary of the Navy should ensure that the Chief of Naval Operations, to the extent practicable, make future operational deployments contingent on demonstrated progress addressing gaps between desired and demonstrated capabilities.

DoD RESPONSE: Concur. This will be part of Task Force LCS.

Accessible Text for Appendix VI: Comments from Department of Defense

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U.S. Government Accountability Office
441 G Street, NW
Washington DC 20548

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“LITTORAL COMBAT SHIPS: ACTIONS NEEDED TO ADDRESS SIGNIFICANT OPERATIONAL CHALLENGES AND IMPLEMENT PLANNED SUSTAINMENT APPROACH”

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DoD RESPONSE: Concur. This will be part of Task Force LCS.

Appendix VII: GAO Contact and Staff Acknowledgments

GAO Contact

Diana Maurer, 202-512-9627 or maurerd@gao.gov

Staff Acknowledgments

In addition to the contact listed above, Sally Newman (Assistant Director), Clarine Allen (Analyst in Charge), Brian Bothwell, Vincent Buquicchio, Breanne Cave, Christopher Gezon, Joanne Landesman (retired), Felicia Lopez, Tara Porter, Michael Silver, Herbert Tinsley, Hai Tran, Cheryl Weissman (retired), Richard Winsor, and Samuel Woo made key contributions to this report. In addition, Cale Jones, Jessica Karnis, Diana Moldafsky, Shelby Oakley, William Reed, Kimberly Schuster, and Nate Young supported the report.

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